



**Programmable
AC Power Source
6560/6590
User's Manual**

Version 1.3
March 2007
P/N A11 000609

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Material Contents Declaration

A regulatory requirement of The People’s Republic of China defined by specification SJ/T 11364-2006 mandates that manufacturers provide material contents declaration of electronic products, and for Chroma products are as below:

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls	Polybromodiphenyl Ethers
	Pb	Hg	Cd	Cr ⁶⁺	PBB	PBDE
PCBA	×	○	○	○	○	○
CHASSIS	×	○	○	○	○	○
ACCESSORY	×	○	○	○	○	○
PACKAGE	○	○	○	○	○	○

“○” indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

“×” indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

1. Chroma is not fully transitioned to lead-free solder assembly at this moment; however, most of the components used are RoHS compliant.
2. The environment-friendly usage period of the product is assumed under the operating environment specified in each product’s specification.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.



CE-Conformity Declaration

For the following equipment:

Product Name: Programmable AC Source

Model Name: 6560/6590

Manufacturer's Name: Chroma ATE Inc.

Manufacturer's Address: 66 Hwa-Ya 1st Rd., Hwa-Ya Technical Park,
Kuei-Shan Hsiang, Taoyuan Hsien, Taiwan

is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States Relating to Electromagnetic Compatibility (89/336/EEC) and electrical equipment designed for use within certain voltage limits (73/23/EEC;93/68/EEC)

For electromagnetic compatibility, the following standards were applied:

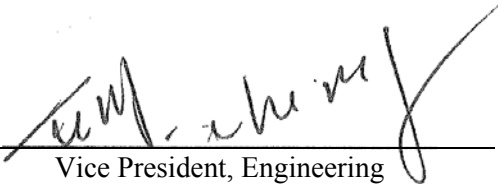
EMC: EN55011 : 1991 (Group I Class A)
 EN60555-2:1987
 EN60555-3:1987
 EN50082-1:1992 IEC 801-2: 1991 –8 kV AD,4 kV CD
 IEC 801-3:1984 – 3 V/m
 IEC 801-4:1988 – 0.5 kV Signal Lines
 1 kV Power Lines

For safety requirement, the following standard was applied:

Safety: EN61010-1(1993)+A2(1995)

Taiwan
Place

May, 2005
Date


Vice President, Engineering

Warning:

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or specific WARNINGS given elsewhere in this manual will violate safety standards of design, manufacture, and intended use of the instrument.

Chroma assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER

Verify that the product is set to match with the line voltage.

PROTECTIVE GROUNDING

Make sure to connect the protective grounding to prevent an electric shock before turning on the power.

NECESSITY OF PROTECTIVE GROUNDING

Never cut off the internal or external protective grounding wire, or disconnect the wiring of protective grounding terminal. Doing so will cause a potential shock hazard that may bring injury to a person.

FUSES

Only fuses with the required rated current , voltage , and specified type (normal blow , time delay , etc.) can be used. Do not use different fuses or short-circuited fuse holders. To do so might cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE




Do not operate the instrument in the presence of flammable gases or fumes.

DO NOT REMOVE THE COVER OF THE INSTRUMENT

Operating personnel must not remove the cover of the instrument. Component replacement and internal adjustment can be done by qualified service personnel only.

WARNING	<i>LETHAL VOLTAGES.</i> Ac sources can supply 426 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.
----------------	---

SAFETY SYMBOLS

	DANGER - High voltage.
	Explanation: To avoid injury, death of personnel, or damage to the instrument, the operator must refer to an explanation in the instruction manual.
	Protective grounding terminal: To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
WARNING	A WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like which may result in injury or death of personnel if it is not rightly observed.

Revision History

The following lists the additions, deletions and modifications in this manual at each revision.

Date	Version	Revised Sections
Nov. 2002	1.0	Complete this manual.
May 2005	1.1	Change the address and phone no. of Chroma.
Aug. 2005	1.2	Add a new function “LCD Sleep Time” in the section of “ <i>Setting of SET UP Menu</i> ”.
Mar. 2007	1.3	Add “ <i>Material Contents Declaration</i> ”.

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1. General Information

1.1 Introduction

This manual describes the specifications, installation, operation instructions, and theory of operation as well as calibration procedure of Chroma 6560/6590 Programmable AC Power Source. In this manual the term, AC Source, stands for Chroma 6560/6590 Programmable AC Source.

1.2 Description

The series of AC source is a high efficiency programmable ac power source, which is capable of simulating a wide variety of AC line conditions, harmonic waveforms, and perform accurate measurements of power. The microprocessor-controlled waveform oscillator generates accurate, stable output voltage and frequency. The PWM design of power stage allows for full volt-ampere into loads. The front panel has both RPG (Rotary Pulse Generator) and keypad controls for setting the output voltage and frequency. The built-in LCD provides a complete operating state of the unit to user, and remote programming is accomplished either by the GPIB bus or the RS-232C serial port.

1.3 Key Features

A. Configuration

- Local operation from the front panel keypad
- Remote operation via GPIB or RS-232C interface
- Protection against Over-power, Over-load, Over-temperature, and Fan-fail
- Temperature-controlled fan speed
- Built-in output isolation relays

B. Input/Output

- Selective output voltage with full scale of 150V/300V
- Remote control using analog voltage reference
- Full-page display for setup and measurement results
- V, I, F, P, CF, and PF measurements
- Remote inhibited control
- AC ON/OFF output signal
- Output transient state acknowledge

1.4 Specifications

The operation specifications of 6560/6590 Programmable AC Power Source are listed below. All specifications have been tested according to the standard of Chroma test procedures. All specifications are based on a remote sense connection, $25 \pm 1^\circ\text{C}$, and resistor load unless specified otherwise.

Model	6560	6590
Output Phase	1 (parallel or series)	1 or 3 selectable
OUTPUT RATINGS		
Power/phase	6000VA	9000VA
Voltage		
Range/Phase	150V/300V(parallel) 300V/500V(series)	150V/300V
Accuracy	0.2% of F.S.	0.2% of F.S.
Resolution	0.1V	0.1V
Distortion	1%	1%
Line Regulation	0.1%	0.1%
Load Regulation	0.2% (series) 0.8 % (parallel)	0.2% (3 phases) 0.8% (1 phase)
Temp. coefficient	0.02% per °C	0.02% per °C
Max. current/phase		
rms	60A/30A/15A (150V/300V/500V)	30A/15A (150V/300V)
peak	180A/90A/45A(45-100Hz) 150A/75A/38A(>100-1KHz)	90A/45A(45-100Hz) 75A/38A(>100-1KHz)
Frequency		
Range	45-1KHz	45-1KHz
Accuracy	0.15%	0.15%
Resolution	0.01Hz (45-99.9Hz) 0.1Hz (100-999.9Hz)	0.01Hz (45-99.9Hz) 0.1Hz (100-999.9Hz)
INPUT RATINGS		
Voltage Range	190-250V, 3φ	190-250V, 3φ
Frequency Range	47-63Hz	47-63Hz
Current	35A Max. /Phase	35A Max. /Phase
Power Factor	--	0.98 Min. under full load
MEASUREMENT		
Voltage/Phase		
Range	0-150V/0-300V	0-150V/0-300V
Accuracy (rms)	0.1%F.S.+0.25%	0.1%F.S.+0.25%
Resolution	0.1V	0.1V

Current/phase		
Range (peak)	0-140A	0-140A
Accuracy (rms)	0.1%F.S.+0.4%	0.1%F.S.+0.4%
Accuracy (peak)	0.2%F.S.+0.4%	0.2%F.S.+0.4%
Resolution	0.01A	0.01A
Power/phase		
Accuracy	1%F.S. (CF<6)	1%F.S. (CF<6)
Resolution	0.01W	0.01W
Frequency		
Range	45-1K Hz	45-1K Hz
Accuracy	0.01%+2count	0.01%+2count
Resolution	0.01Hz	0.01Hz
OTHERS		
Efficiency	80% typ.	80% typ.
Protection	OPP, OLP, OTP, FAN Fail	OPP, OLP, OTP, FAN Fail
Temperature		
Operating	0-40°C	0-40°C
Storage	-40 to +85°C	-40 to +85°C
SAFETY	CE (include LVD and EMC requirement)	

Remarks

- *1: Maximum distortion for voltage varies from half to full range with linear load.
- *2: Test with sine wave and remote sense.

1.5 Names of Parts

1.5.1 The Front Panel

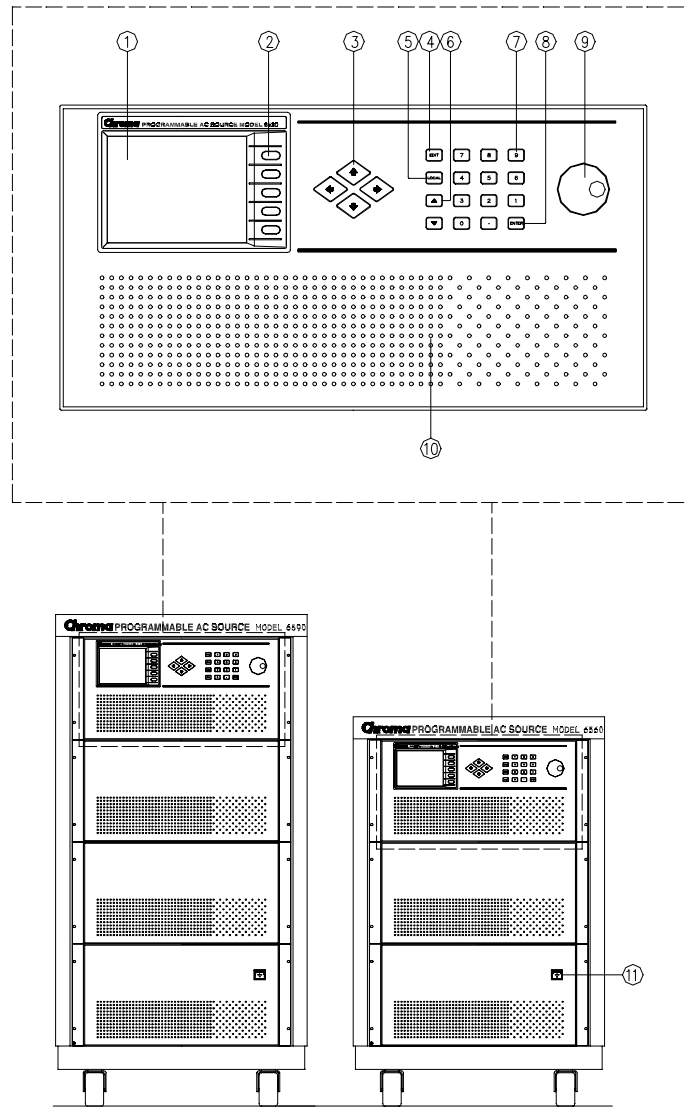

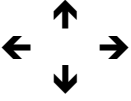







Figure 1-1 The Front Panel

Front Panel Description

Item	Symbol	Description
1		Display: The LCD is to display configuration, output setup, and measurement results.
2		Soft keys: Five soft keys are located at the right side of the LCD. Each of them gives a command as indicated on the corresponding command block on the LCD next to the soft keys to guide the user unless that block is blank. Each valid soft key denotes the command string lying within the symbol of a soft key; for example, CONFIG represents the soft key next to command block “CONFIG” for entering configuration menu.
3		Cursor moving keys: These four keys are to move the cursor to different directions respectively. In normal mode (non-editing mode), pressing any of them will change the cursor position. In editing mode, pressing ← or → will move the cursor digit by digit for programming the parameter.
4	Edit	Edit command key: Press this key can enter into or quit from editing mode while programming V or F.
5	Local	Local command key: Press this key can switch the control of AC source from remote operation to local using the keypad on the front panel.
6	 and 	Up and Down keys : Press  to search upward for the desired programming parameter. Press  to search downward.
7	0 to 9 and .	Numeric and decimal keys: You can program numeric data by pressing the numeric and decimal keys.
8	ENTER	ENTER key: Press this key to confirm the setting of parameters.
9		RPG: You can input the programming data or options by turning the RPG to the desired ones.
10		Airflow inlets: Cool airflow enters the AC source through these holes.
11		Main power switch: It is to power on or off the device.

1.5.2 The Rear Panel

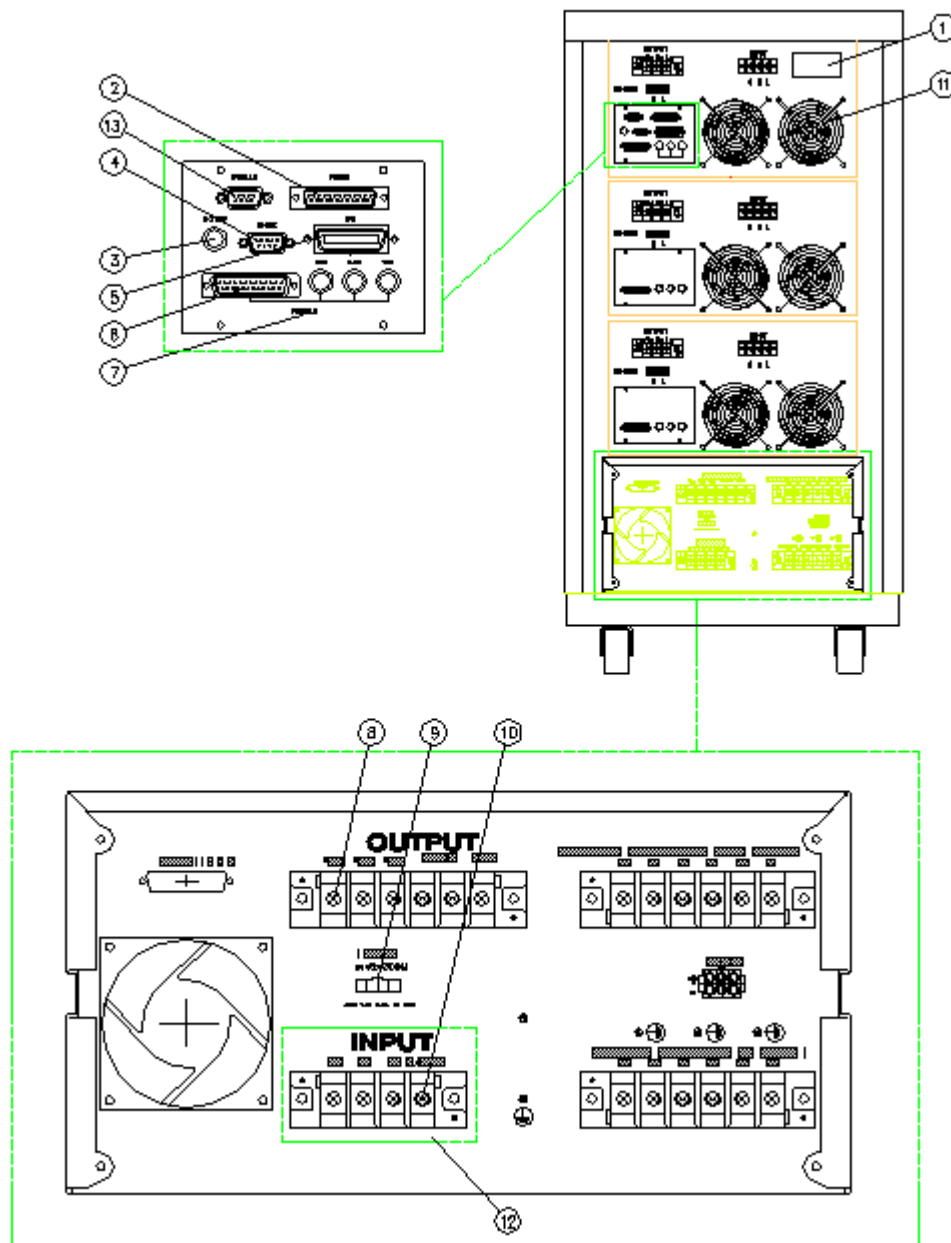


Figure 1-2 The Rear Panel

Rear Panel Description

Item	Name	Description
1	Label	The label contains model number, series number of the AC source and its input ratings.
2	Printer Port	The 25-pin, D-type female connector is for transmitting measurement data to a parallel printer.
3	Ext. Ref.	The BNC connector inputs control waveform amplitude from external devices.
4	RS-232C	The 9-pin, D-type female connector transfers control commands to and from the remote PC for remote operation.
5	GPIB Connector	A GPIB bus connector is connected to the AC source for remote operation.
6	System Interface: System I/O	The 25-pin, D-type male connector is for parallel, three phase data communication.
7	System Interface	These three BNC signals: SYNC, CLOCK, VREF are for parallel, three phase synchronization.
8	Output Connector	This connector outputs power to the loading device.
9	Remote Sense Connector	It senses directly at the load terminals to eliminate any voltage drop on the connecting cable. Make sure to connect the remote sense connector terminal "L" to the load terminal "L", and "N" to the "N" of the load. Reverse polarity is not allowed.
10	Power Line in Connector	Power line input is connected to the AC source via this connector.
11	Cooling Fan	The fan speed automatically increases or decreases as temperature rises or falls.
12	Safety Cover	This is to protect the user from being shocked.
13	TTL I/O	The 9-pin, D-type male connector transfers the control signals of trigger in, remote inhibit, transient and AC ON.

2. Installation

2.1 Inspection

First, inspect any damage that may have occurred during the shipment after unpacked the instrument. Save all packing materials in case the instrument has to be returned.

If any damage is found, please file a claim against the carrier immediately. Do not return the instrument to the factory without obtaining the prior RMA acceptance from Chroma.

2.2 Preparation for the Use

Before begins the instrument must be connected with an appropriate AC line input. As the instrument is cooled by fans intelligently, it must be installed in an area with sufficient space for air circulation. It should be used in an area where the environment temperature does not exceed 40°C.

To connect the input/output cable, you must remove the safety cover that mounted on the rear panel first. Refer to sections 2.3.2, 2.4, and 2.5 for corresponding cables connection. After completing the connection, you should mount the safety cover back to the rear panel again.

2.3 Requirements of Input Power

2.3.1 Ratings

Input Voltage Range: 190-250 V_{LL}, 3 phases 4 wires Δ , or
329-433 V_{LL}, 3 phases 5 wires Y
Input Frequency: 47-63 Hz
Max. Current/Phase: 6560/6590: 35 A

⚡ Caution

The AC source can be damaged if it is operated at an input voltage that is beyond its configured input range.

2.3.2 Input Connection

The input terminal block is located on the instrument rear panel. The power cord must be rated at least for 85°C. The power line input must have a current rating, which is greater than or equal to the maximum current rating of the AC source.

⚡ CAUTION

There are two input voltage rating models, one is 380 V_{LL} 3 phases 5 wires (Y), and the other is 220 V_{LL} 3 phases 4 wires (Δ). Be careful to verify the model you have, and make sure that the main voltage is suitable for the model.

See Figure 2-1 and do the following steps one by one:

1. Remove the safety cover from the back of AC source.
2. Open the line clamp on the safety cover, and screw on the power cord to the instrument through the cable gland.
3. Position the power cord, and tighten the cable gland to secure the clamp.
4. Connect the ac lines to the terminal blocks of the AC source as Figure 2-2 shows.
5. If you need to connect the load to AC source, please refer to section 2.4 for output connection.
6. Slip the safety cover over the ac input terminal strip, and secure the cover with two screws.

⚠ WARNING

To protect operators the wire connected to the GND terminal must be connected to the ground. Under no circumstances shall this AC source be operated without an adequate ground connection.

Installation of the power cord must be done by a professional in accordance with local electrical codes.

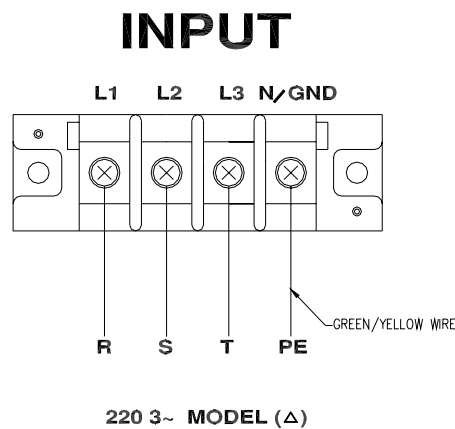


Figure 2-1 6560/6590 220 3~Δ Input Connection

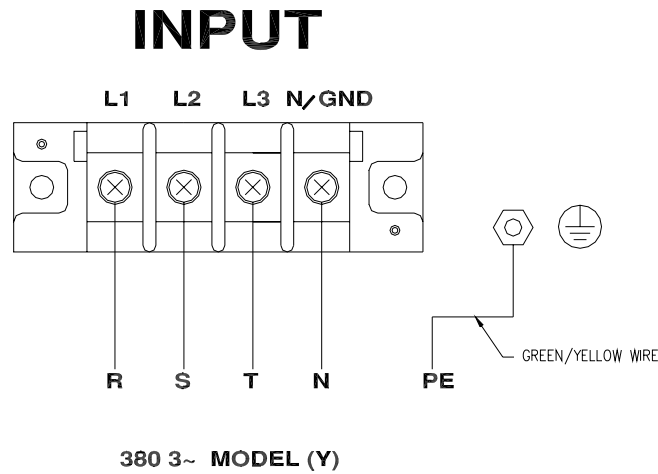


Figure 2-2 6560/6590 380 3~Y Input Connection

2.4 Output Connection

The output terminal block is located in the rear side of AC source. Load connection to the AC source is done at the output terminals. To meet the safety requirements the wires to the load must use gauges large enough to prevent from overheating while carrying the output current. See Figure 2-3 to 2-6 below.

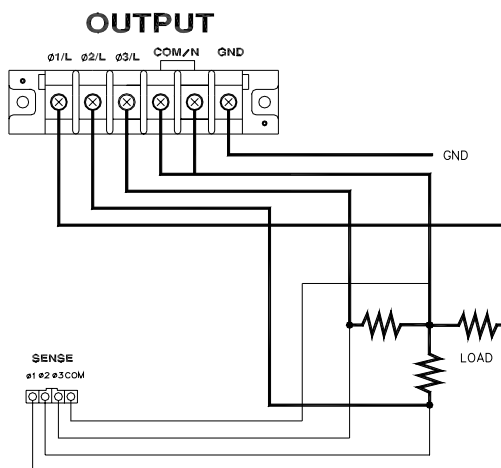


Figure 2-3 6590 Three-Phase Output Connection

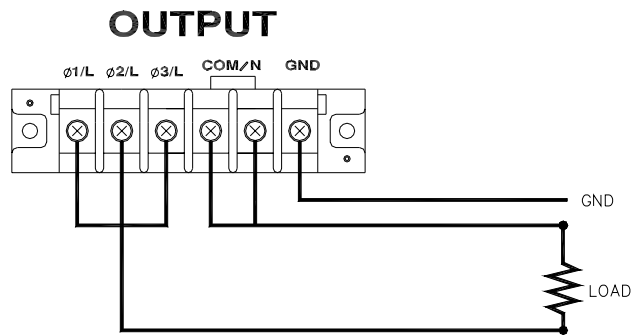


Figure 2-4 6590 One-Phase Output Connection

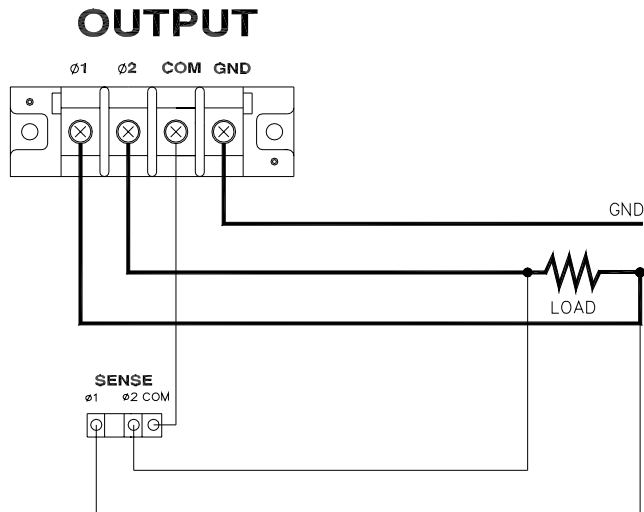


Figure 2-5 6560 Series Output Connection (Note: $V_{LOAD} = 2 \times V_{set}$)

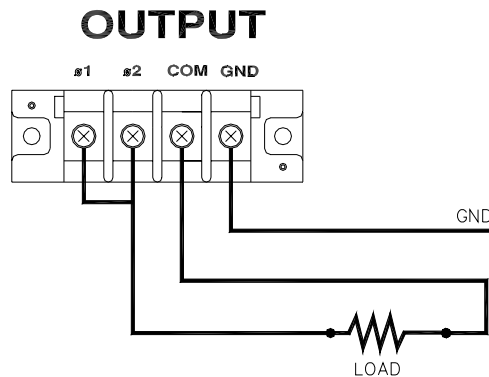


Figure 2-6 6560 Parallel Output Connection

AWG No.	Capacity ¹	AWG No.	Capacity ¹
14	25 A	8	60 A
12	30 A	6	80 A
10	40 A	4	105 A

Table 2-1 The Characteristics of AWG (American Wire Gauge) Copper Wire

1. The capacity is based on the ambient temperature of 30°C with conductor rates at 60°C.

2.5 Remote Sense Connection

The AC source remote sense function monitors the load voltage instead of the output terminal of 6560 series and 6590 3-phase mode. It ensures the delivery of accurate voltage as programmed at the load by compensating the output voltage drop over the connecting cable automatically. You have to set Remote Sense ON so as to enable this function.

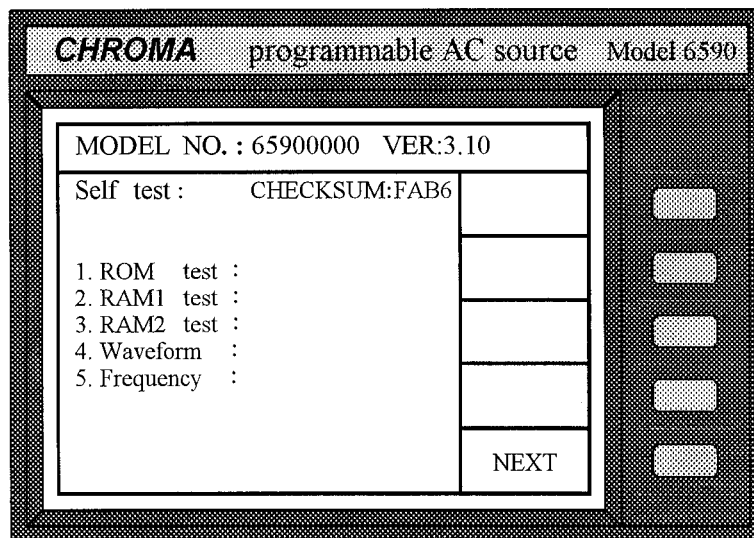
Connect the sensing leads from “Ø1”, “Ø2”, “Ø3” and “COM” terminals on the remote sense to the load as shown in Figure 2-3 to 2-6. As the sensing leads carry only a few milliamperes, the wires for sensing are much lighter than the load leads. The sensing leads are part of the feedback path of the AC source. They must be kept at a low resistance in order to maintain the best performance. Connect the sensing leads carefully so that they will not be open-circuited. If the sensing leads are left unconnected or become open-circuited during operation, the AC source will disable the output, and show “OPEN INT”. The sensing leads must be a twisted pair to minimize the pickup of external noise. The sensing leads need to be connected to the load as close as possible. To reset the AC source, press **ENTER** over two seconds.

2.6 The Procedures of Power-on

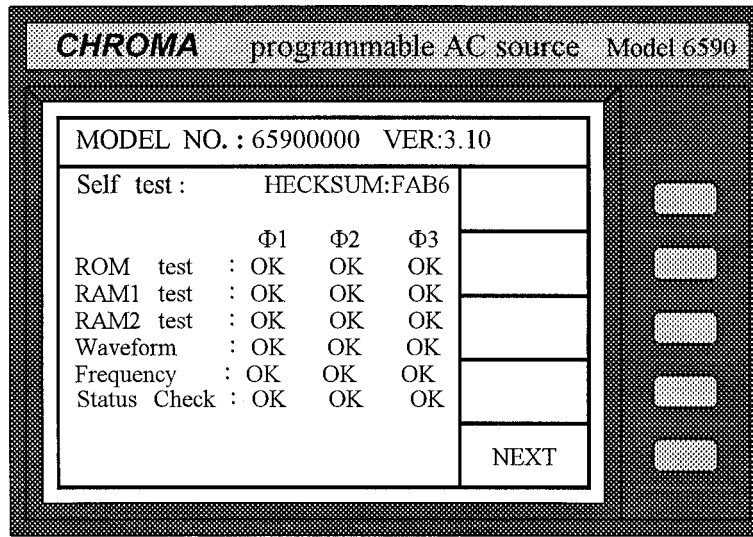
WARNING

Before turning on the instrument, all protective earth terminals, extension cords, and devices connected to the instrument must be connected to a protective ground. Any interruption in the protective grounding will cause a potential shock hazard that might injure people.

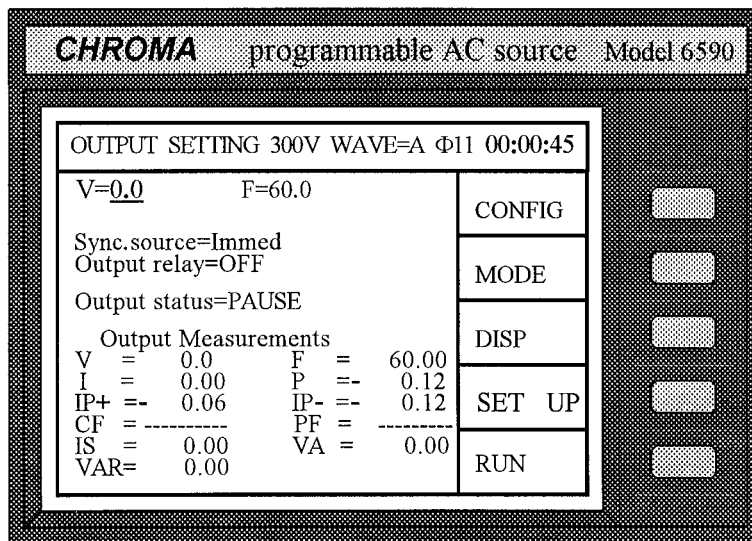
Apply the line power, and turn on the power switch on the front panel. No load shall be connected to the output terminal block. The AC source will do a series of self-tests every time it is turned on. The LCD on the front panel will light up and display as follows:



After completed the self-test routines, the display will show an "OK" at the right side of each test item to indicate that there is no problem as below.



If any failure is detected on a certain item, an “NG” will be shown at the right side of that item and beep. It takes about eight seconds to complete the routines of self-test. If no errors are found, the LCD will display as follows:



Following table shows all the error messages and recommended actions:

Item	Error Message	Description	Action
1	Rom test NG	System memory test fails.	Consult your dealer for assistance.
2	Waveform test NG	Waveform circuit test fails.	Consult your dealer for assistance.
3	Frequency test NG	Frequency test fails.	Consult your dealer for assistance.
4	RAM1/RAM2 test NG	Battery back-up memory test fails, or memory is bad.	Press 0 & 8 simultaneously to initialize the memory.
5	Status Check NG	The NG phase interface test fails.	Consult your dealer for assistance.

① NOTICE

If you initialize the memory, all of the saved data may be initialized; therefore you must check the saved data before doing so.

3. Local Operation

The AC source can be configured to operate in local or remote mode. The operation in remote mode through a remote GPIB controller or RS-232C will be described in Chapter 6 *Remote Operation*. This chapter describes the operation in local mode through the keypad on the front panel for data entry and test. The AC source is configured for local operation when turned on.

3.1 Operation through Keypad

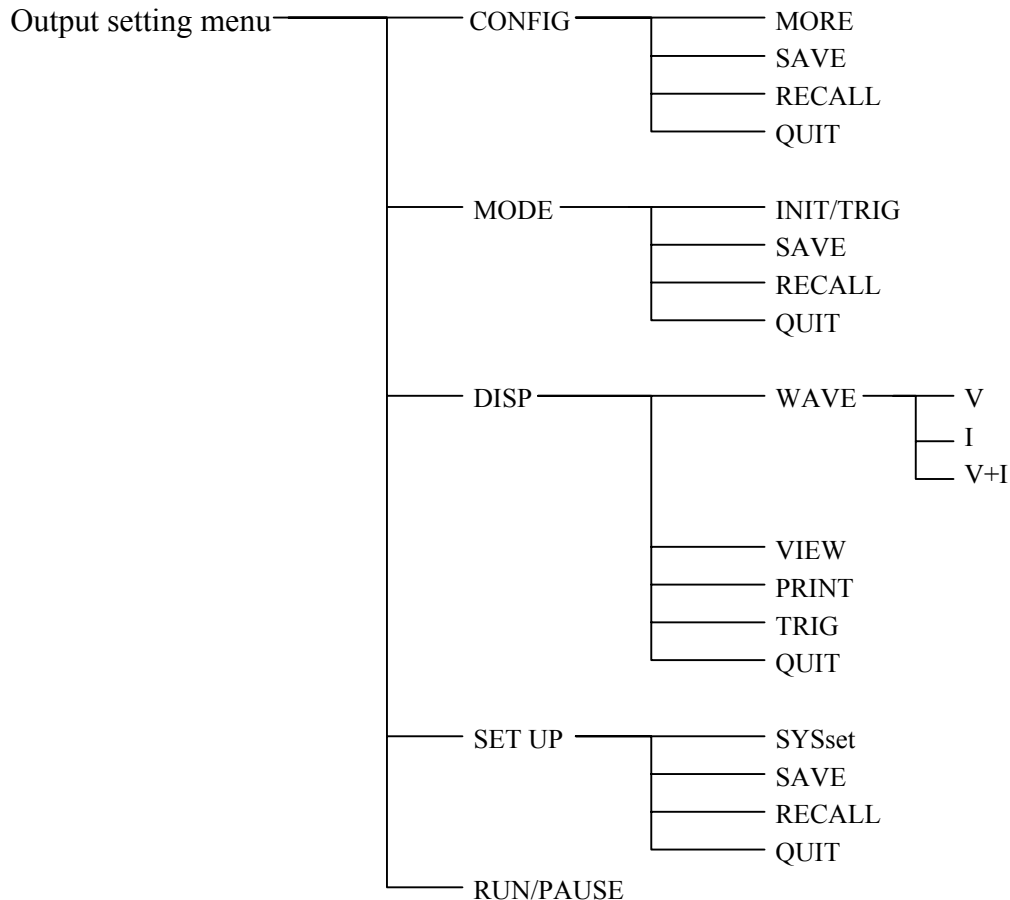
3.1.1 Introduction

The AC source provides a user-friendly programming interface to use the keypad on the front panel. Each LCD display on the AC source that represents an operational menu is divided into three zones.

- (1) **Headline:** The first row of LCD displays characters in reverse video. This line provides information of current operation function, output parameters, and the total operation time after power-on.
- (2) **Command zone:** The farthest right column of the LCD is divided into five blocks. Each block represents a soft key for a minor function, which can be executed by pressing the key next to it. Hence, all of the command sets are structured as a command tree. Each node of the command tree presents an operational menu. Also, on each node the LCD always provides five choices for user to enter into other nodes, or quit from the current node.

Sample nodes (operational menu) in the command tree is shown below:

The command tree:



- (3) Parameters zone: The remaining area offers information for users to program the AC source, to view the current status, and to collect measurement results, etc.

3.1.2 Data Entry

Before explaining each of the menus, the common operations in the parameters zone are described below:

Cursor Movement

Use any of the cursor movement keys: **↑**, **↓**, **←**, **→** to move the cursor to the desired parameter for programming.

There are two ways to set the parameters. One is in normal mode, and another is in editing mode. Following example shows how to set output voltage.

Normal Mode

- (1) Press the numeric keys **1**, **3**, **5**, **.**, **2**, **ENTER** to set V=135.2V.
- (2) Press **▲** or **▼** key repeatedly, or keep pressing any of them until the value, V=135.2V, is shown on the LCD. Then, press **ENTER** to confirm. Increasing or decreasing value is done through the farthest right digit. Some parameters are specific strings like Sync. source=Immed/phase, Trigger=AUTO/MANUAL, Output relay=ON/OFF, etc. that can be selected by **▲**/**▼** or PRG for programming.

① NOTICE

Once a parameter is modified, you need to press **ENTER** to update the current data and save them into memory; otherwise the old data will remain when exiting.

Editing Mode

In editing mode you can set parameters immediately without pressing **ENTER** to confirm. The mode only allows you to set V or F parameter. When you move the cursor to V parameter, and presses **Edit** to enter into the editing mode, the cursor will show as below:

V=135.2_ F= 60.0

Set the output voltage to 132.2V as follows:

Move the cursor to the position of digit 5 using **←**, and press **2** to set V=132_.2. Press **Edit** to enter into editing mode. Editing mode is useful when you want to change V or F parameter for only one digit, or to set output V or F in step change. In this mode you can also increase or decrease the value of current position by pressing **▲**, **▼** or PRG. Press **Edit** again to quit the editing mode.

3.1.3 Output Setting

The Output Setting on the screen is the AC source main operation menu accepts AC output parameters, including V, F Sync. and source, etc. In this menu you can activate the AC source by pressing the soft key **RUN** to obtain the measured results at the terminals of the devices under test.

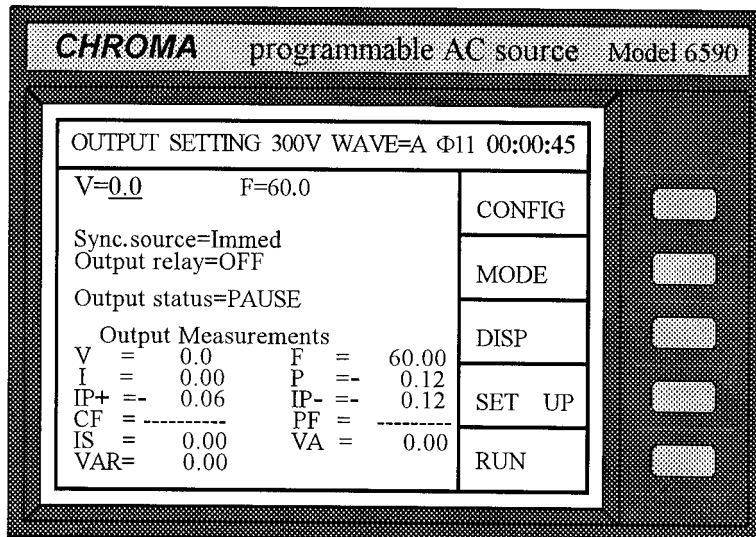
3.1.3.1 Setting Output Voltage and Frequency

① NOTICE

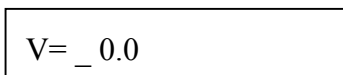
The maximum output voltage of ONE power stage is limited by the waveform peak value, which is about 425 V_{peak}. 6590 has three power stages that can be selected in three phases or one phase (parallel). 6560 has two power stages that can be selected in series or parallel. The output is programmed in units of RMS volts. For a sine wave, the maximum AC voltage of ONE power stage that can be programmed is 300 V. So, for 6590 the maximum Line to Line voltage is 519 V_{rms} in 3-phase mode, and 300 V_{rms} in 1-phase mode. For 6560 the maximum voltage is 300 V_{rms} in parallel mode, 500 V_{rms} in series mode. The set voltage programmed here is for each power stage only. If you want to get 400 V_{rms} output of 6560 in series mode, you have to program 200 V on the display. For other waveforms, the maximum voltage may be different. Appendix E is the maximum programmed voltage for non-sine wave.

When you turn on the AC source, the state of default output is set in the Configure menu of Power on output status. Set the output to V=135.2 V_{rms}, F=50.0 Hz as follows:

1. After you have powered on the AC source, and accomplished the self-test (or exited from any other menu by pressing **QUIT**), the LCD will display a main operational picture on the screen as below:



The line where the cursor stays indicates the AC source is waiting for the voltage value input.



- Input the value of V as 135.2 either by pressing **1**, **3**, **5**, **.**, **2**, **ENTER** to set the voltage to 135.2 Vrms or following the data entry procedures described in section 3.2.2.

V=135.2 F= _60.00

- Move the cursor to set the frequency by inputting 50 Hz for F, and pressing **5**, **0**, **ENTER**.

V= 135.2 F= 50.00

① NOTICE

Voltage ranges from 0 to 300V in the step of 0.1V. Frequency ranges from 45 to 1000 Hz in the step of 0.01/0.1Hz.

3.1.3.2 Setting the Output Transition Phase

The AC source can control the transition angle of the output waveform. It offers Sync. source of “Immed” and “phase”. Immed means the AC source outputs transition immediately when you change the output V or F. Sync. source=phase means the output transition synchronizes with a reference phase angle.

Set the output “phase” of AC source and the phase angle to 90 degrees as follows:

- Move the cursor to the command of Sync. source.

Sync. source= Immed

- Press **▼** to change the parameter from “Immed” to “phase”, and press **ENTER**.

Sync. source=phase phase= _ 0.0

- Press **9**, **0**, **ENTER** to set the transient phase angle to 90 degrees.

Sync. source=phase phase=90.0

Set the output “Immed” of AC source as follows:

1. Move the cursor to the command of Sync. source.

Sync. source= phase phase=90.0

2. Press **▲** or **▼** to set Immed, and then press **ENTER** to confirm.

Sync. source=Immed

① NOTICE

The AC source allows you to program different phase from 0 to 359.9 in the step of 0.1 degree.

3.1.3.3 Setting the Output Relay

There is a relay on the output of AC source for connecting with a load. When the output relay is “ON”, it means the output relay is closed in spite of the AC source is in **QUIT** mode. When the output relay is “OFF”, it means the output relay is closed only when the output status is in **RUN** mode. If the output status is in **QUIT** mode, the output relay will be opened.

Set the output relay to ON as follows:

1. Move the cursor to the command of output relay.

Output relay=OFF

2. Press **▲**, **ENTER** to set the output relay to ON. A click is sounded when the output relay is activated.

Output relay=ON

3.1.3.4 The Output Status

There are two status of output. One is PAUSE, and another is RUN.

PAUSE: It means the output of AC source is inactive.

RUN: It means the output of AC source is active according to the parameters set.

3.1.3.5 Programming of Three Phase Unbalanced Voltage

You can program the 3-phase output with different voltage for 6590:

1. Move the cursor to the command of phase select.

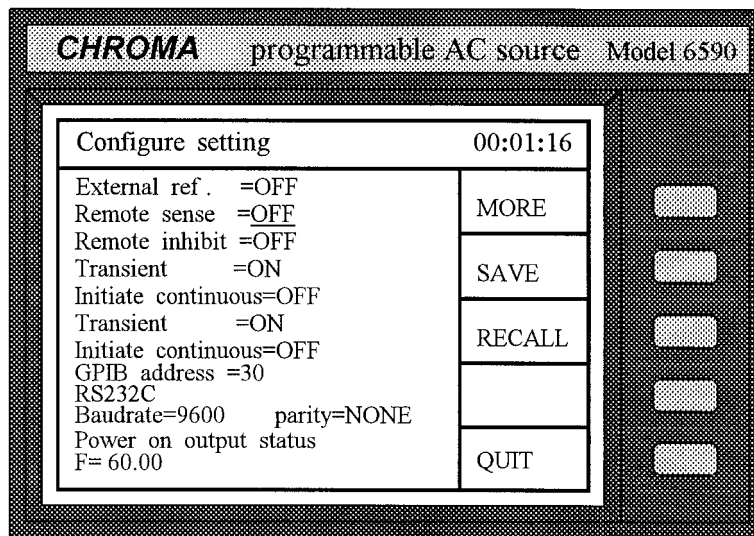
phase select = Ø1

2. Press **▲** or **▼** to set Ø1, and press **ENTER**.
3. Set the voltage for Ø1.
4. Repeat steps 1~3 for setting the voltage to Ø2 and Ø3. Then, press **RUN**, you will get different voltage as you program at output.
5. If you choose Ø1+Ø2+Ø3, the programmed voltage is for all three phases.

3.1.4 Setting the Configuration

The AC source provides a lot of useful features such as Remote Sense, External reference, Transient acknowledgement, and Waveform selection, etc. To use these powerful features you must program relevant parameters according to the application requirements using the configuration setup.

Press the soft key, **CONF**, the LCD displays the following picture:



3.1.4.1 Remote Sense

Remote sense is to eliminate voltage drop on the connection cables from the AC source output terminal to the load. For details of wire connection please refer to section 2.5 *Remote Sense Connection*. The setup procedures are shown below:

1. Move the cursor to the command of Remote Sense.

Remote Sense = <u>OFF</u>

2. Press **▲**, **ENTER** to change the option to ON.

Remote Sense =ON

① NOTICE

1. There is no “remote sense” function for 6560 in “parallel” mode and 6590 in “ONE phase” mode.
 2. Before selecting “ON” to enable the remote sense function, the remote sense leads must be connected to the load (see 2.5); otherwise the AC source will detect errors and stop output.
-

3.1.4.2 External Reference

The AC source allows you to use the controlled signal from external devices to set its output. The BNC connector on the rear panel for external reference lets you apply DC signal to AC source for output voltage setting. The output voltage (V_{out}) responds linearly proportional to the controlled DC level with voltage ranging from 0 to 10 V. V_{out} can be calculated using the following formula:

$$V_{out} = V_{control} / 10 \text{ V} \times V \text{ range}$$

Remark: The formula mentioned above is applicable when the output waveform is sinusoidal. However, if the waveform is not sinusoidal, you may refer to *Appendix F* for output voltage RMS scaling.


To set V_{out} to 60Vrms:

1. Select range = 300V in setup menu, apply external DC = 2V, and V_{out} = 60Vrms.
2. Select range = 150V in setup menu, apply external DC = 4V, and V_{out} =60Vrms.

The setup procedures are shown below:

1. Move the cursor to the command of External ref.

External ref. =OFF

2. Press , **ENTER** to change the option to ON.

External ref =ON

① NOTICE

When external ref. is set to ON, the output voltage (V_{out}) will respond to the external control DC voltage level. You cannot control V_{out} amplitude through the keypad on the front panel until external ref. is set to OFF again. However, you can still program and output other parameters.

3.1.4.3 Remote Inhibit

The output of AC source can be inhibited by external control or triggered manually. There are three states for remote inhibit: OFF, Live, and Trigger.

OFF: It is to disable the remote inhibit.

Live: The output of AC source will be disabled if TTL signal is active, but will be automatically recovered if TTL signal is removed or inactive.

Trigger: The output of AC source will be disabled if TTL signal is active, and will remain so even TTL signal becomes inactive. To reset the AC source you have to press **ENTER** for over two seconds.

The setup procedures are shown below:

1. Move the cursor to the command of Remote inhibit to set the inhibition by the TTL signal from external control.

Remote inhibit =OFF

2. Press **▼** to change the option to LIVE, then press **ENTER**.

Remote inhibit =LIVE

① NOTICE

The remote inhibit is a TTL “active LOW” signal transferred via the TTL I/O connector. For details please refer to pin assignment in *Appendix E*.

3.1.4.4 Transient State Acknowledgement

The AC source can be sent as a TTL signal to synchronize with the external devices when the output state changes.

The setup procedures are shown below:

1. Move the cursor to the command of Transient to enable the transient acknowledgement state.

Transient =OFF

2. Press **▼**, **ENTER** to change the option to ON.

Transient =ON

① NOTICE

The transient acknowledgement sends a TTL active LOW pulse (10 μ S) via the TTL I/O connector. For details please refer to pin assignment in *Appendix E*.

3.1.4.5 Auto Initialization by Trigger

When operating in “MODE”, you may take advantage of any of the following modes: STEP, PULSE, and LIST. After finished the output setting, you can enable the output by either of the following two ways:

- A. Press **INIT** to initialize the process, and follow **TRIG** to trigger output, or
- B. Press a single trigger key to use auto initialization.

The setup procedures are shown below:

1. Move the cursor to the command of Initiate continuous.

Initiate continuous=OFF

2. Press **▲**, **ENTER** to change the option to ON.

Initiate continuous=ON

3.1.4.6 GPIB Address

The AC source offers the mode for remote operation as well. For details please refer to *Chapter 5 Remote Operation*. Prior to remote operation you need to set the GPIB address to 10 as follows:

1. Move the cursor to the command line of GPIB address.

GPIB address =30

2. Press **1**, **0**, **ENTER** to set address to 10.

GPIB address =10

① NOTICE

The address space ranges from 0 to 30.

3.1.4.7 The Setup of RS-232C

The AC source offers another remote operation through the RS-232C bus. The communication protocol is set as follows:

Set baud rate=19200 and parity=ODD.

1. Move the cursor to the command line of Baudrate.

```
Baudrate=4800 Parity=EVEN
```

2. Press **▲** or **▼** or turn RPG to select 19200, then press **ENTER**.

```
Baudrate=19200 Parity=EVEN
```

3. The cursor moves automatically to “parity”. Press **▲** or **▼** or turn RPG to select “ODD”, then press **ENTER**.

```
Baudrate=19200 Parity=ODD
```

① NOTICE

The options for baud rate are 2400/4800/9600/19200. The options for parity are EVEN/ODD/NONE.

3.1.4.8 The Default of Power-On

The AC source allows you to store the output frequency as default before powering off.

Set power-on to F=50 Hz.

1. Move the cursor to the line of “F=” under the “Power on output status”.

F= 60.0

2. Press **5**, **0**, **ENTER** to set F=50.

F= 50.0

3.1.4.9 Saving

To save all of the system data except those in the modes of STEP, PULSE and LIST as follows:

1. Press **SAVE**, and the LCD displays as below.

Save to group 0

2. Press the numbers from 0 to 2 on the numeric keypad to select the desired memory group.
3. Press **ENTER** to confirm it.

① NOTICE

1. Selection of memory group is programmable by pressing the numeric keypad only. Other methods, including the use of rotary knob and **▲** or **▼** keys, are invalid when you try to program a memory group to be “Saved” or “Recalled”.
 2. The AC source provides three memory groups: 0, 1, and 2. The memory group 0 keeps power-on defaults. The setups saved into the memory group 0 will be recalled automatically when the AC source is powered on again while those saved into other memory groups must be recalled manually. See section 3.1.4.10.
-

3.1.4.10 Recalling

To recall the system data as follows:

1. Press **RECALL**, and the LCD displays as below.

Recall from group 0

2. Press the numeric keypad to select the desired memory group.
3. Press **ENTER** to confirm it.

3.1.4.11 More

Press the soft key **MORE** to enter into another display for output phase and waveform selection.

3.1.4.11.1 The Selection of Phase Status

In 6560 there are two modes, “parallel” and “series”, for selection. In 6590 there are two modes, “one phase” and “three phase”, for selection as well. If you select “three phase” and press **ENTER**, there will be $\varnothing 2=120.0$, $\varnothing 3=240.0$ appearing at the lower part of the display. They are the phase shift of $\varnothing 2$ and $\varnothing 3$ reference to $\varnothing 1$, and can be programmed as you like.

Note: You can easily verify the mode you are using from the output main menu headline.

$\varnothing 13$: “series” mode for 6560 and “3-phase” mode for 6590.

$\varnothing 11$: “parallel” mode for 6560 and “1-phase” mode for 6590.

3.1.4.11.2 Internal Waveform Generator

The AC source provides two independent sets of waveforms, A and B. Both of the waveforms contain sinusoidal, square, clipped sinusoidal, 30 sets of built-in waveforms, and 5 sets of user-defined waveforms.

To set waveform A as square wave:

1. Move the cursor to the command of WaveformA.

WaveformA=SINE

2. Press **▲** or **▼** to change the option to “SQR”, then press **ENTER**.

WaveformA=SQR

To set waveform B as clipped Sin wave, THD: 10%

1. Move the cursor to command of WaveformB.

WaveformB=SINE

2. Press **▲** or **▼** to change the option to “CSIN”, then press **ENTER**, and LCD prompts clipped by AMP or THD.

WaveformB=CSIN AMP= 0.0

When you select “CSIN”, the clipped sinusoidal wave, you are requested to program the clipped percentage as follows:

3. Press **▲**, **ENTER** to change the option to THD.

WaveformB=CSIN THD%= _0.0

4. Press **1**, **0**, **ENTER** to set the distortion to 10%.

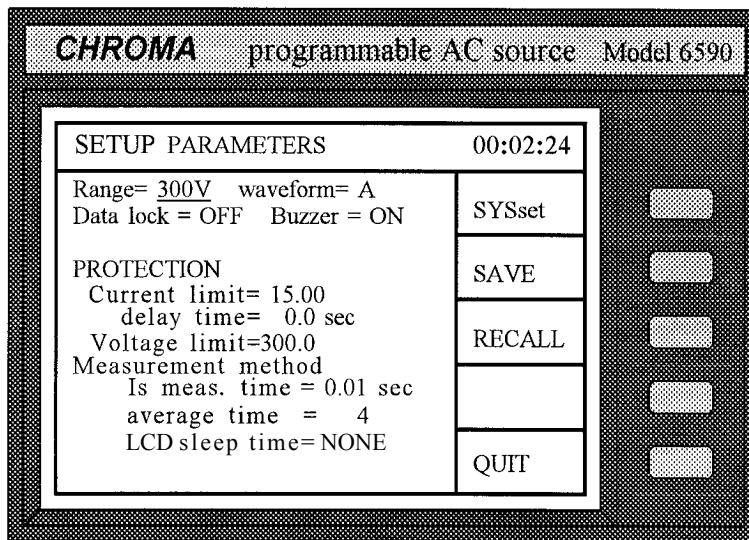
WaveformB=CSIN THD%=10.0

① NOTICE

1. The clipped sine is programmed by “AMPlitude” or “Total Harmonic Distortion”. Programming ranges from 0 to 100% for amplitude (100%: no clipped sine), and from 0 to 43% for THD (0%: no distortion).
 2. User-defined waveform is defined on a remote PC and downloaded from it.
 3. For details of factory DST waveform refer to *Appendix A*.
 4. When you select non-sinusoidal waveform, the range of output voltage may change to correct rms output voltage.
-

3.1.5 Setting the SET UP Menu

The “SET UP” menu manages the setups for V full range, waveform, data lock, and protections, etc. Press **SET UP** to enter into the “SET UP” menu, and the LCD will display as follows:



3.1.5.1 The Output Range

The AC source supplies full range of output voltage with options of 150 V or 300 V.

To set the output voltage range to 150 as follows:

1. Move the cursor to the command line of Range.

Range= 300 waveform= A

2. Press **▲** or **▼** to change the option to "150", then press **ENTER**.

Range= 150 waveform= A

① NOTICE

The AC source will set output voltage as 0 V first in order to eliminate voltage spike when range changes. Then, it will change to the set value. It may cause UUT to shut down or get bad if the output is active, and range changes.

3.1.5.2 Selecting the Waveform

The AC source offers two internal waveform generators: A and B. For details in programming Waveform please refer to 3.2.4.11.2. You can select one of them as output waveform.

To select waveform B as active buffer as follows:

1. Move the cursor to the command line of “Waveform=”.

```
Range= 150  waveform= A
```

2. Press **▲**, **ENTER** to change the option to B.

```
Range= 150  waveform= B
```

① NOTICE

The AC source will display the selected waveform on the headline of output main menu.

3.1.5.3 The Data Lock

The AC source allows you to lock data entries, so the pre-defined parameters can be protected from being modified by unauthorized people.

The setting procedures of data lock are shown below:

1. Move the cursor to the command line of “Data lock”.

```
Data lock = OFF  Buzzer = ON
```

2. Press **▲**, **ENTER** to change the option to ON.

```
Data lock = ON  Buzzer = ON
```

① NOTICE

You must select OFF to unlock.

3.1.5.4 Setting Up the Buzzer

The buzzer of AC source beeps when you press the keypad on the front panel, or turns the PRG knob. You can turn it off if no need.

To turn off the buzzer as follows:

1. Move the cursor to the command line of “Buzzer=”.

Data lock = off Buzzer = <u>ON</u>

2. Press **▲**, **ENTER** to change the option to OFF.

Data lock = off Buzzer = OFF

3.1.5.5 Protection

Limitation of output RMS current, output voltage, and delay time are the parameters for triggering overload protection. The discussion of protection/limitation in this section is about user-programmable protection, not hardware protection.

The procedures for setting Current limit = 20A, Delay time = 1 sec., and Voltage limit = 250V are described below:

1. Move the cursor to the command line of “Current limit=”.

Current limit= <u>_15.00</u>

2. Press **2**, **0**, **ENTER** to change the value to “20.00”.

Current limit=20.00

3. The cursor moves to the command line of “delay time=” automatically.

```
delay time=  _0.0 sec
```

4. Press **1**, **ENTER** to change the value to “1.0”.

```
delay time=  1.0 sec
```

5. The cursor moves to the command line of “Voltage limit=” automatically.

```
Voltage limit =  _150.0
```

6. Press **2**, **5**, **0**, **ENTER** to change the value to “250.0”.

```
Voltage limit =250.0
```

① NOTICE

1. Delay time is valid for eliminating transient current spike, which is useless in voltage protection.
2. Current limit ranges from 0 to 100 in the step of 0.01 A.
Delay time ranges from 0 to 100 in the step of 0.1 sec.
Voltage limit ranges from 0 to 300 in the step of 0.1 V.
3. The output of AC source will be disabled when protection is active, and will remain so even the condition is released. To reset the AC source you have to press **ENTER** for over two seconds.

3.1.5.6 The Methods of Measurement

The AC source measures the performance of a dynamic loading in a short period of time. The indicators of performance, containing V_{rms} , I_{rms} , I_{p+} , I_{p-} , P_{true} and F , are measured every 200 mS. Then, the AC source takes as many successive readings as possible at user's request, and calculates the average for presentation. Besides, I surge is measured from the beginning of output transition to the end of I_s measurement time.

For example, set the I surge measurement for 0.5 sec. and average it eight times. The setup procedures are shown below:

1. Move the cursor to the command line of “Is meas. time=”.

Is meas. time = _ 0.01

2. Press **0**, **.**, **5**, **ENTER** to change the value to 0.5 sec.

Is meas. time = 0.50

3. The cursor moves to the command line of “average times=” automatically.

average times = _ 4

4. Press **8**, **ENTER** to set the average times to 8.

average times = 8

① NOTICE

1. The measurement time of I surge ranges from 0 to 30 in the step of 0.01 sec. The average times range from 1 to 20.
 2. If the displayed value is too changeable to be read, you can select a higher value of average times; for example, larger than 8 to stabilize it.
-

3.1.5.7 The Setup of LCD Sleep Time

The AC source allows the user to set LCD sleep time. There are four choices for LCD sleep time: NONE, 5 min, 20 min and 60 min. The LCD backlight will be turned off when the AC source reaches time limit of LCD sleep time without any operation in local mode. The LCD backlight will be turned on once again when the user operates in local mode.

The procedures for setting LCD sleep time: 5 min, are described as below:

1. Move the cursor to the command line of “LCD sleep time= NONE”

LCD sleep time= NONE

2. Press **▲** to change the option from NONE to 5 min, then press **ENTER**.

LCD sleep time= 5 min

3.1.5.8 Saving/Recalling

Please refer to section 3.1.4.9 and 3.1.4.10 for related information.

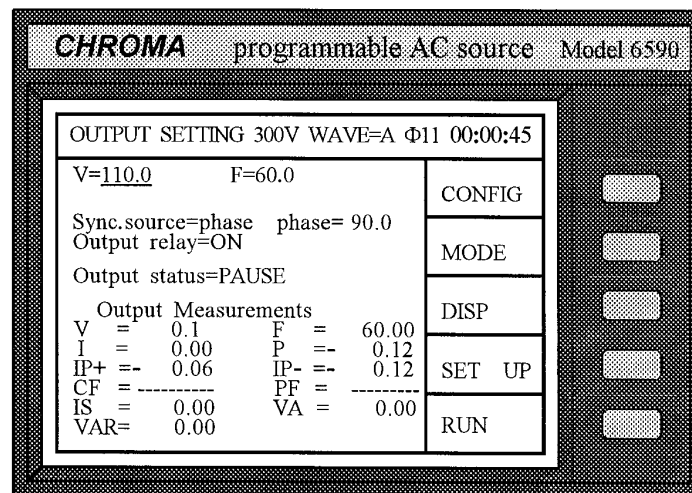
3.1.5.9 SYS setting

This function is reserved for maintenance and factory testing only.

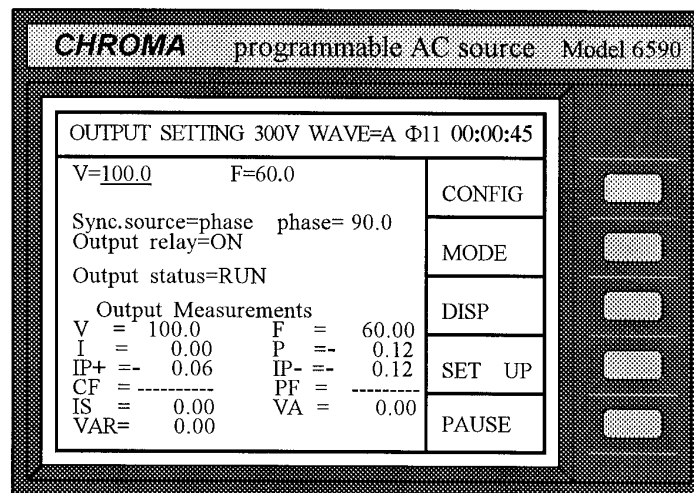
3.2 Applications

3.2.1 The Execution of Output

In the output main menu, you can press the soft key **RUN** to enable the execution of output. When you press **RUN**, the LCD will change from “Output status=PAUSE” to “Output status=RUN”, and the command string of the original “RUN” will change to “PAUSE” (Press the soft key **PAUSE** to disable output when output is in “RUN”). The following example of LCD indicates the states when you toggle the output between “RUN” and “PAUSE”. If the output is inactive, the LCD will show as follows:



Press **RUN** to enable the active output, and the LCD will show as follows:



① NOTICE

You may observe the measured values under Output Measurements on the lower part of the LCD. For detail description of the measurement please refer to section 3.3.

3.2.2 The Modes

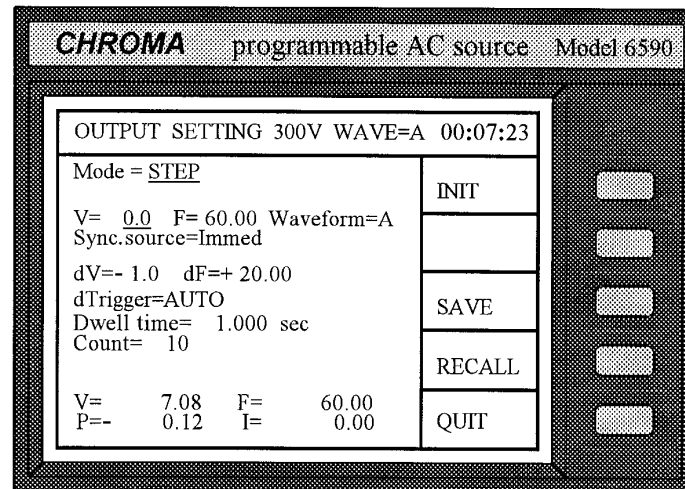
The AC source provides three powerful modes: STEP, PULSE, LIST for you to program the output transient states and fulfill various needs in application.

STEP It makes the output change to its set values step by step.

LIST It makes the output change through a number of values as specified by parameters in the LIST menu.

PULSE It makes the output change to its set value for a specific period of time as specified by parameters in the PULSE menu.

In the main menu, you can enter into the screen for the application programming modes by pressing the soft key **MODE**. The LCD displays as below:



You may select modes among STEP, PULSE, and LIST for specific applications using or . The respective modes and application examples are described in the following sections.

Note: There is one more command “controlled phases = Ø1/Ø1+ Ø2+Ø3” for the 6590 3-phase mode. You can program these Mode Waveforms for Ø1 only by selecting Ø1, or for all Ø1, Ø2, Ø3 by selecting Ø1+Ø2+Ø3. The voltage changes simultaneously in time, not in their own phases. Ø1 is the reference voltage.

3.2.2.1 Mode = STEP

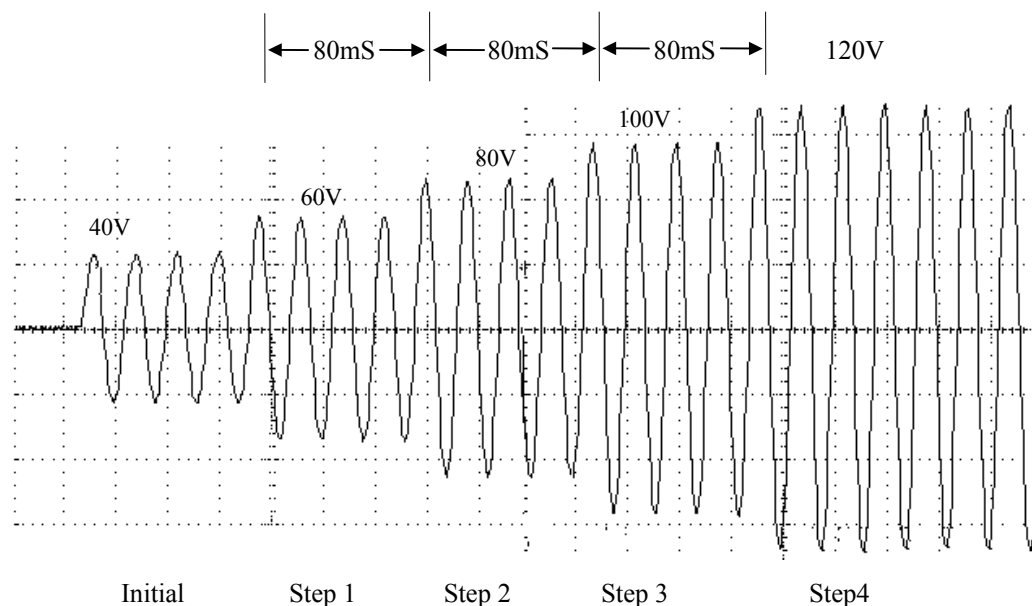


Figure 3-1 STEP Transients

In STEP mode, the AC source offers Voltage and Frequency for being stepped up or down after the programmed preset time (Dwell time). It also offers selectable waveforms with which the programmable output transient phase is to synchronize. Moreover, it provides cycle time for repeat execution.

Example: The following example shows a voltage output generated from the STEP mode.

The initial state is V=40 V, F=50 Hz, V steps up with the increment of dv=20 V, F keeps constantly, dF=+0.00, Sync. Source=phase, phase=0, Trigger=Auto, Dwell time=40 mS, and count=4 times (see Figure 3-1).

1. Select the STEP mode following the procedure described in 3.2.2, or press **MODE** to enter into the transient state setting, and press **▲** or **▼** to select the STEP mode. Then, press **ENTER**.

```
MODE = STEP
```

2. The cursor moves down to the line of "V= 0.0".

```
V= _ 0.0 F= 60.00
```

3. Press **4**, **0**, **ENTER** for V, and the cursor moves to F= _60.00.

```
V= 40.0 F= _60.00
```

4. Press **5**, **0**, **ENTER** for F.

```
V= 40.0 F= 50.00
```

5. The cursor moves to the line of Sync. source. Press **▼**, **ENTER** to select phase and press **▼** or **ENTER** to set phase=0.0.

Sync. source=Immed

Sync. source=phase phase=0.0

6. Move the cursor to “dV=”, use **▲** to change “-” to “+”, then press **ENTER**. The cursor moves to “0.0”. Press **2**, **0**, **ENTER** for dV.

dV= - 0.0 dF= + 20.00

dV= + 20.0 dF= ± 20.00

(“+” means the increment of output voltage, while “-” is the decrement of output voltage.)

7. The cursor moves to “dF= + 20.00”. Press **ENTER** or **→** to keep the increment of F “+”. Press **0**, **ENTER** to set frequency unchanged.

dV= + 20.0 dF= + 0.00

8. The cursor moves to “dTrigger=AUTO”. Press **ENTER** or **▼** to skip the setting of dTriggering, and move the cursor to the line of Dwell time.

Dwell time= -1.000 sec

9. Press **0**, **.**, **0**, **4**, **ENTER** for Dwell time.

Dwell time= 0.040 sec

10. The cursor moves to the line of “Count=”. Press **4**, **ENTER** for count. Count=0 is not allowed.

Count= 10

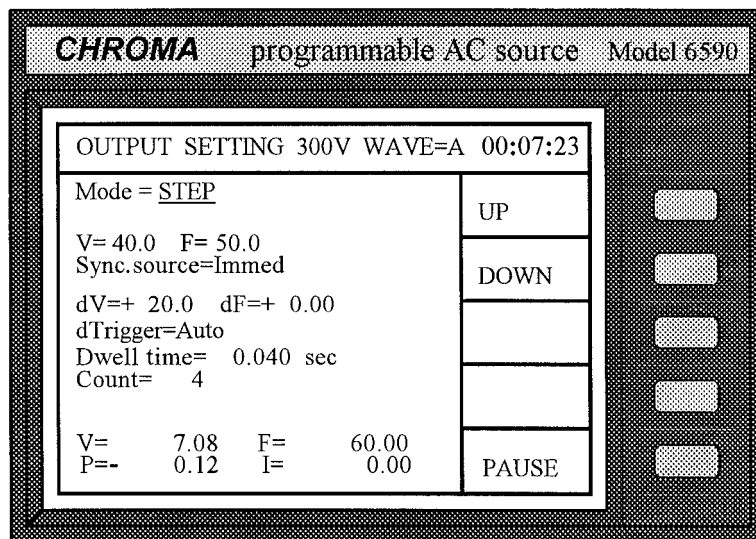
Count= 4

11. Upon completion, press **INIT** and **TRIG** to start the output power of the programmed parameters.

12. Press **QUIT** to exit the STEP mode.

Note 1: The AC source always measures the V, F, P, and I when dwell time is longer than two seconds. The readings of measurement are displayed on the lower part of the LCD to indicate the performance of load.

Note 2: There are two operation modes, AUTO and MANUAL. AUTO means the V/F is run automatically step by step when the last step of Dwell time is finished, or the soft key **PAUSE** is pressed (see Note 3). MANUAL means each step of V/F will run whenever the soft key **UP** or **DOWN** is pressed. Each time output changes one step only.



Note 3: During the execution mode of dTrigger=AUTO, you may press the soft key **PAUSE** to stop the output. If you need to hold the output temporarily, you can press the soft key **HOLD**. Press **CONT** to resume the output.

Note 4: The pre-programmed output can be saved and recalled by the soft keys **SAVE** and **RECALL**. For details please refer to the example in 3.1.4.9 and 3.1.4.10.

Note 5: When continuous=ON is initiated in Configure setting, the soft key **INIT** will display for the first time. Press **INIT** and it will change to **TRIG**. Press **TRIG** to start the output

power of the programmed specifications in STEP mode.

Note 6: Upon the completion of the output in STEP mode, the last step will display and the menu is updated. The AC source will continue to output till you press **PAUSE** in a fixed mode. The same condition is applied to the output status.

3.2.2.2 Mode = LIST

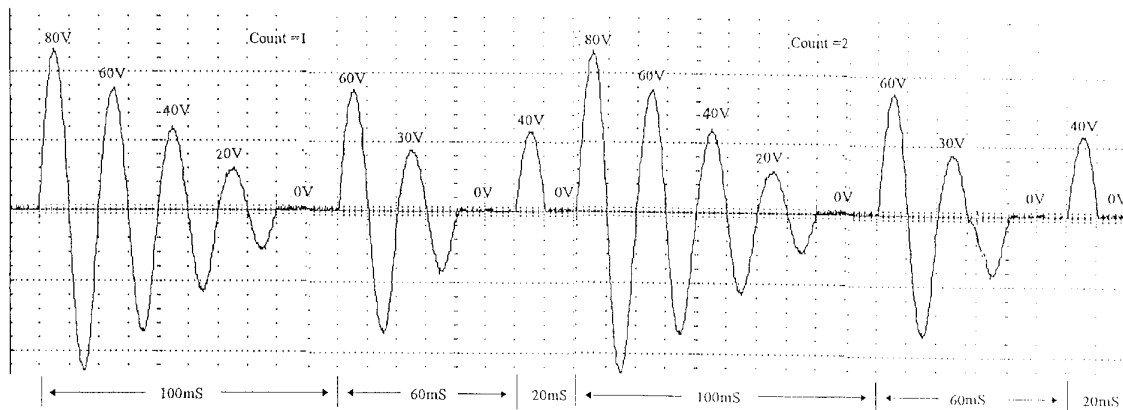


Figure 3-2 LIST Transients

In LIST mode, you can specify the output transient state using the parameters of V, F and Time step by step.

Example:

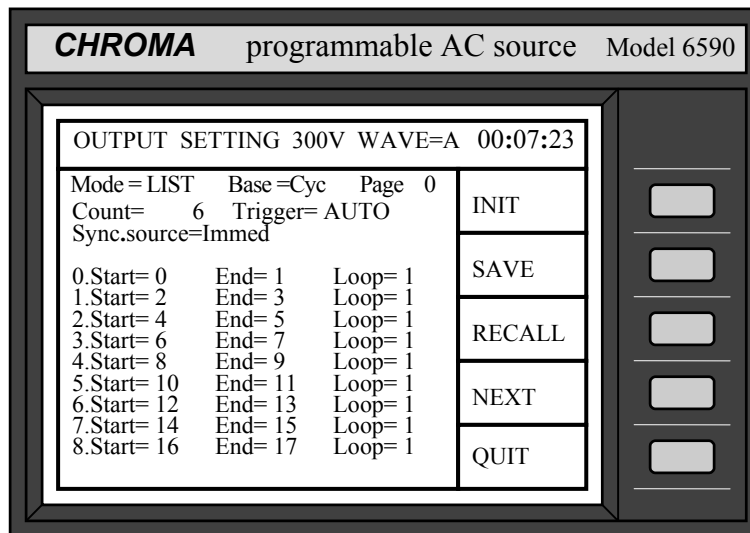
Initial V and F : V = 40V, F = 50Hz, and
Trigger=Auto, Sync. source=phase, phase=90 degrees

Vs0= 80V, Ve0= 0V, F0= 50Hz, Time0= 100mS Waveform0= A', StepNo0= 5
Vs1= 60V, Ve1= 0V, F1= 50Hz, Time1= 60mS Waveform1= A', StepNo1= 3
Vs2= 40V, Ve2= 0V, F2= 50Hz, Time2= 20mS Waveform2= A', StepNo2= 2

Stop the sequence by Time3=0mS, and repeat the entire cycle for two times (See Figure 3-2).

The procedures are described below:

1. Use the procedures described in 3.2.2 to select LIST mode, and the LCD will display as follows:



2. Move the cursor to the line of “Base =”. Press **▲** or **▼** to select “Base = Tim”, then press **ENTER**. There are two base parameters: Cycle & Time.

Base = Cyc

Base = Tim

3. Press **2**, **ENTER** to repeat counts. Count=0 means infinity (skip Trigger=“AUTO” by pressing **ENTER** and leave it unchanged.)

Count= 2

4. Move the cursor to the line of “Sync. source=”. Select Sync. source and press **▲** till “phase” is displayed, then press **ENTER**.

Sync. source=Immed

Sync. source=phase phase= _ 0.0

5. The cursor moves to “phase” automatically. Press **9**, **0**, **ENTER** to set the phase angle.


```
Sync. source=phase phase= 90.0
```

6. The cursor moves to the first line of loop setup.

```
0.Start= _0 End= 0 Loop= 0
```

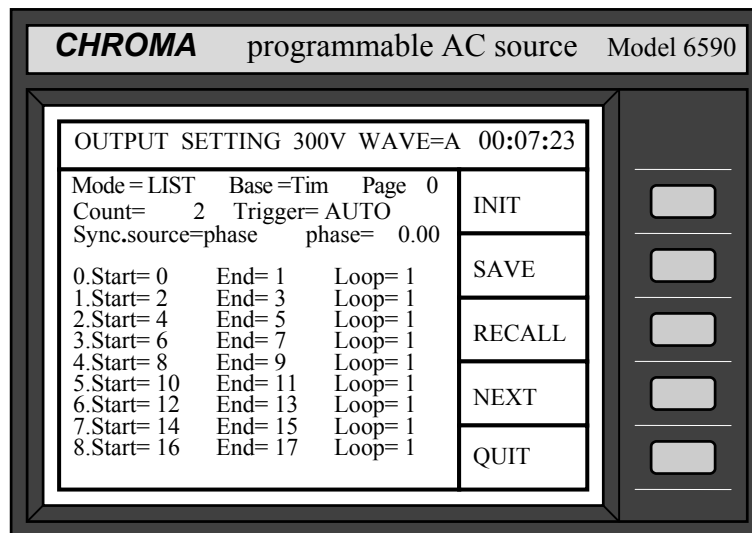
Two rules must be followed in loop setup:

- A. The sequence of End must be greater than or equal to the Start in each line.
- B. The sequence of End must be less than the Start in the next line.

7. Press **0**, **ENTER** to set Start sequence, **1**, **ENTER** to set End sequence, and **1**, **ENTER** to set Loop number.

```
0.Start= 0 End= 1 Loop= 1
```

8. Repeat step 7 till Loop setup is finished as below:



9. Press the soft key **NEXT** to go to Page 1. The cursor moves to the first line, “0.Vstart=0 Vend=0”.
10. Press **8**, **0**, **ENTER** to set sequence 0 start voltage= 80V. The cursor moves to “Vend=0.0”. Leave it unchanged by pressing **ENTER**.
11. The cursor moves to sequence 0 “F= 60.00”. Press **5**, **0**, **ENTER** to set frequency=50 Hz. The cursor moves to “Time = 0 ms”. Press **1**, **0**, **0**, **ENTER** to set sequence 0 time= 100 mS.

F= _ 60.00 Time = 0 ms

F = 50.00 Time = 100 ms

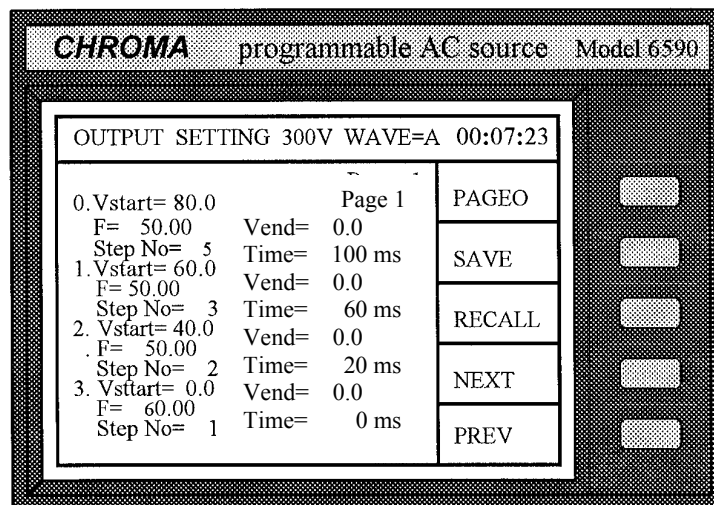
12. The cursor moves to “Step NO= 0”. Press **5**, **ENTER** to set Step=5.

Step NO= 5

① NOTICE

1. The Step NO cannot be 0. When Step NO=1, only Vstart will run. When Step NO=2, only Vstart and Vend will be run.
2. The time resolution of AC source for LIST mode is 1 mS. When the Time divided by Step NO is less than 1 mS, the AC source will change Step NO every 1 mS for output.
3. The voltage resolution in LIST mode is 1mV. Some unexpected situations would happen when $\Delta V/\text{Step}$ scale is smaller than 1mV.

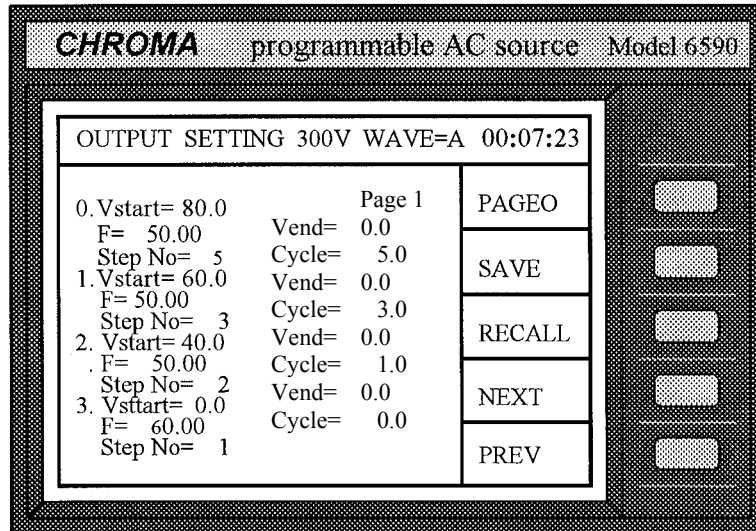
13. Repeat step 10 and 12 to set sequence 1, 2 until sequence setup is finished as follows:
(For any sequence to which time specified as 0, the corresponding sequence will not be run.)



14. If you want to change the base of timing to cycle, please go to Page0, and move the cursor to “Base=Tim”. Press **▲** or **▼** to select “Base=Cyc”, then press **ENTER**. (There is no relationship between Time and Cycle.)

15. Press **NEXT** to go to Page1. Time in each sequence is substituted by Cycle.

16. Edit cycle of sequence 0, 1, 2 and update Page1 as follows:



17. Upon completion, press **PAGE0** to go to Page0, **INIT** to initiate LIST mode, and **TRIG** to start the output power of the programmed specifications in LIST mode.

18. Press **QUIT** to exit the LIST mode, and the LCD will return to the main operational menu.

Note 1: Programmable parameters are listed in *Appendix B*.

Note 2: When you program the steps of V/F exceeding page0, press **NEXT** to let the LCD display extend to other pages, and **PREV** to go back to the previous page. Besides, press **PAGE0** can return to page0 directly. The number of total sequences is 40, from 0 to 39.

Note 3: The pre-programmed output can be saved and recalled by the use of the soft keys **SAVE** and **RECALL**. For details please refer to the example of operation in 3.1.4.9 and 3.1.4.10.

Note 4: If the “initiate continuous=” is set to ON, **INIT** will not display after the first round of output. You may press **TRIG** again if you wish to output in the same LIST mode for more times. If the “initiate continuous=” is set to OFF, you need to press **INIT** to initiate it.

Note 5: If Trigger=MANUAL, press **TRIG** so that the AC source will run the programmed

parameters for one time only. It has the same result as Count=1.

Note 6: Upon the completion of the output in LIST mode, the last sequence status will not be kept in the output. The AC source will output the values of V, F in a fixed mode if “Output Status = RUN”. Output is disabled when “Output Status = PAUSE”.

3.2.2.3 Mode = PULSE

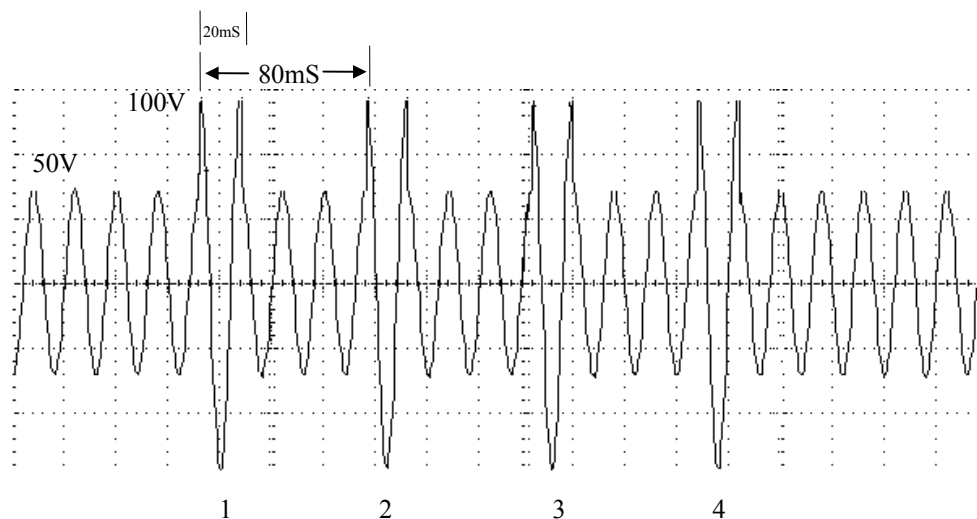


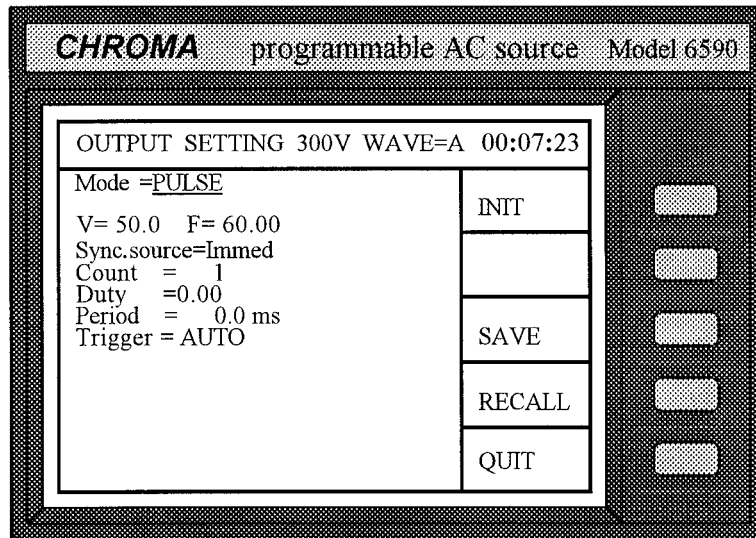
Figure 3-3 PULSE Transients

In PULSE mode, you are allowed to specify duty percent on top of the programmed output transient state. An example indicating how to program the output with specifications is given below:

Output follows the internal waveform generator A under V=50V, F=50Hz, and output=RUN; the pulse criterion is V=100V, F=50Hz, Trigger=Auto, Sync. source=phase, phase=90.00 degrees, Duty =25%, and output duration=80mS, and repeat for count=2 times (see Figure 3-3).

The procedures are listed below:

1. Refer to 3.1.3, set the output V and F to V=50V, F=50Hz respectively, and press **RUN** to activate the outputs. Then, press **MODE** and select the PULSE mode. The LCD displays as follows:



2. Move the cursor down to the line of “V=50.0”.

V= _ 50.0 F= 60.00

3. Press **1**, **0**, **0**, **ENTER** for V. The cursor moves to the line of “F= 60.00”.

V=100.0 F= _ 60.00

4. Press **5**, **0**, **ENTER** for F.

V=100.0 F= 50.00

5. Then, move the cursor to the next line by pressing **ENTER** or **↓**.

Sync. source=Immed

6. Set Sync. source to phase by pressing **▲** or **▼**, or turning the rotary knob, then press **ENTER**.

Sync. source=phase phase= _ 0.00

7. Press **9**, **0**, **ENTER** for phase angle.

Sync. source=phase phase=90.00

8. The cursor moves to “Count=1”. Press **2**, **ENTER** for the repeated count number. Count=0 means infinity.

Count = _ 2

9. The cursor moves to the line of “Duty”. Press **2**, **5**, **ENTER** for duty cycle.

Duty = _ 0.00

Duty = 25.00

10. The cursor moves to the line of “Period”. Press **8**, **0**, **ENTER** for period.

Period = _ 0.0

Period = 80.0

11. Leave Trigger=AUTO unchanged.

12. Upon completion, press **INIT** and **TRIG** to start the output power of the programmed pulse.

13. Press **QUIT** to exit PULSE mode and return to the main menu.

Note 1: If Trigger=MANUAL, press **TRIG** to run the programmed parameters one time. It has the same result as count=1.

Note 2: Upon completion of PULSE output, the last sequence status will not be kept on the output. The AC source will output the values of V, F in a fixed mode if “Output Status = RUN”. Output is disabled when “Output Status = PAUSE”.

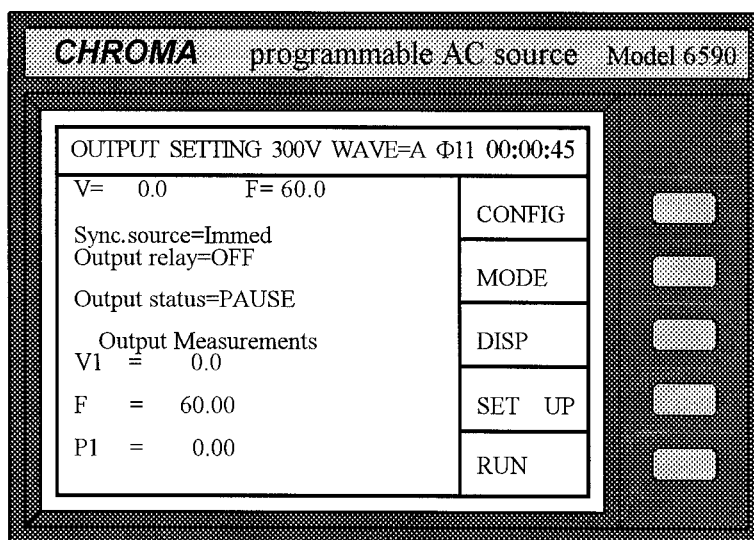
Note 3: The condition of pre-programmed output can be saved or recalled using **SAVE** or **RECALL**. For details please refer to the example in 3.1.4.9 and 3.1.4.10.

3.3 Measurement

The AC source can measure the actual performance of a load connected to it without using an extra measuring instrument. When the AC source is active, it measures the V, I, F, P, etc. of a load for each phase. You can select the measurement point at the load connector (remote sense= ON), or at the AC source output connector.

3.3.1 The Selection of Measurement Items

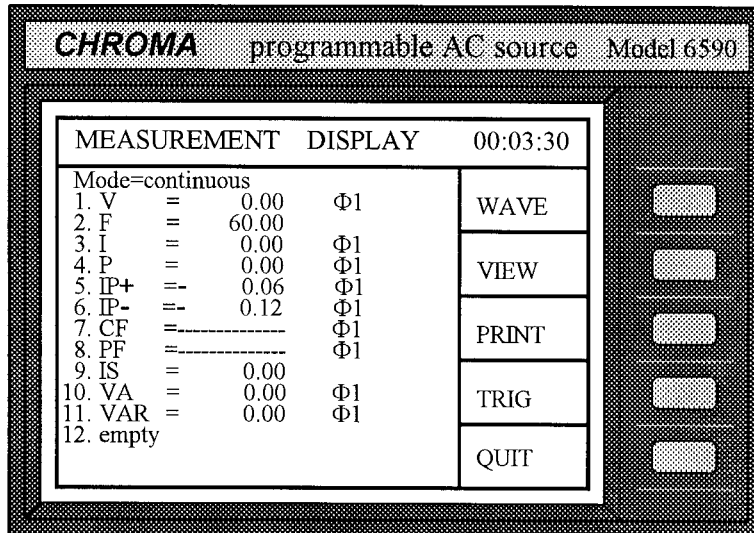
The AC source can display concurrently up to 12 measurable readings, including V, P, I, Ip+, Ip-, CF, PF, VA, Var, F, Ptot, and Is. You can select different measurement functions to display the measured readings. If you select less than three measurement functions, the LCD will display the measurement in enlarged characters as follows: (The lower half of the main menu is the display area of measurement.)



When the output parameters for measurement are more than three, the LCD will display in normal characters.

The procedures for selecting the measurement functions are described below:

1. Enter into the measurement display menu by pressing the soft key **DISP** in the main menu. The LCD displays as follows:

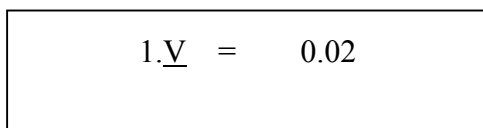


(It is the factory default setting for all measurement items.)

2. Display the readings in a continuous way, or display a single measurement per trigger by turning rotary knob, or pressing or (leave “continuous” unchanged.)

Note: You may use **TRIG** for measurement by manual trigger if select “single”.

3. Move the cursor to the first display item. The number “1” in front of V indicates the display position of measurement function.



4. Turn the rotary knob clockwise, or press , and the measurement functions will change one by one in the following order:

V => P => I => IP+ => IP- => CF => PF => VA => VAR =>
 F => Ptot => Is => empty => (return to V)

Note 1: Turn the rotary knob counterclockwise, or press , the item will appear in reverse order.

Note 2: The option “empty” means that nothing is displayed for a corresponding item.

5. Select a desired measurement function, and press **ENTER** to confirm. The cursor moves to the second column automatically.

6. You can select the phase Ø1, Ø2 (or Ø3 for 6590) by turning the rotary knob and pressing **ENTER** to confirm it. The cursor moves to the next item of the first column. When you return to the main menu, these measurement items will display on the lower half of the screen as shown in the above example.

Note: If you select more than three items, the odd items will be displayed on the left column, and the even items on the right. If the selected items are less than or equal to three, they will be listed with only one column in enlarged characters.

7. Repeat step 4, 5, and 6 for the remaining items.

3.3.2 Measurement Functions

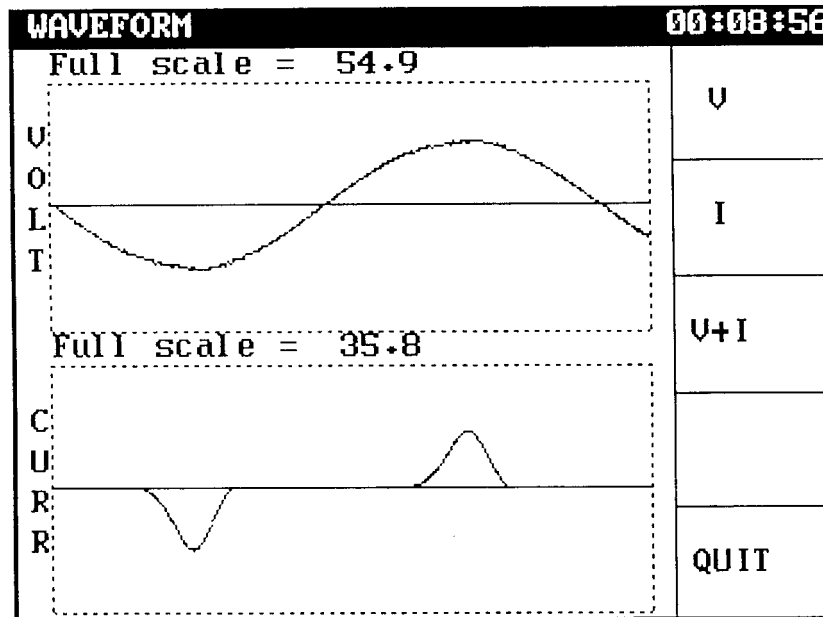
The AC source offers 12 measurement functions. All of the functions can be specified to display in the main menu as stated in the previous section. The definitions of the functions are listed in the following table:

Function	Definition
V	It is the measurement readings of Voltage in Volts. (True RMS measurement)
F	It is the measurement readings of Frequency in Hertz.
I	It is the measurement readings of Current in Amperes. (True RMS measurement)
P	It is the true Power measurement in Watts.
Ip+	It is the positive I peak measurement in Amperes, and the peak value measured in every 200 mS. For details please refer to 3.1.5.6.
Ip-	It is the negative I peak measurement in Amperes, and measured similarly as Ip+.
CF	It is the Crest Factor, and its calculation formula = Ipeak/Irms.
PF	It is the Power Factor, and its calculation formula = true power/ (Vrms × Irms)
Is	It is I surge, and only measured from the occurrence of output transition till the end of “Is meas. time” as defined in 3.1.5.6.
VA	It is Apparent Power in Watts, and its calculation formula = Vrms × Irms
VAR	Its calculation formula = $\sqrt{VA^2 - P^2}$
Ptot	It is the sum of the power of all phases = P ₁ +P ₂ (+P ₃)

Table 3-1 Available Measurement Functions

3.3.3 The Display of the Output Waveforms of V & I

If you want to view the measured waveform of V or I, you can press **DISP** in the main menu, then **WAVE**, and the LCD will show as follows:



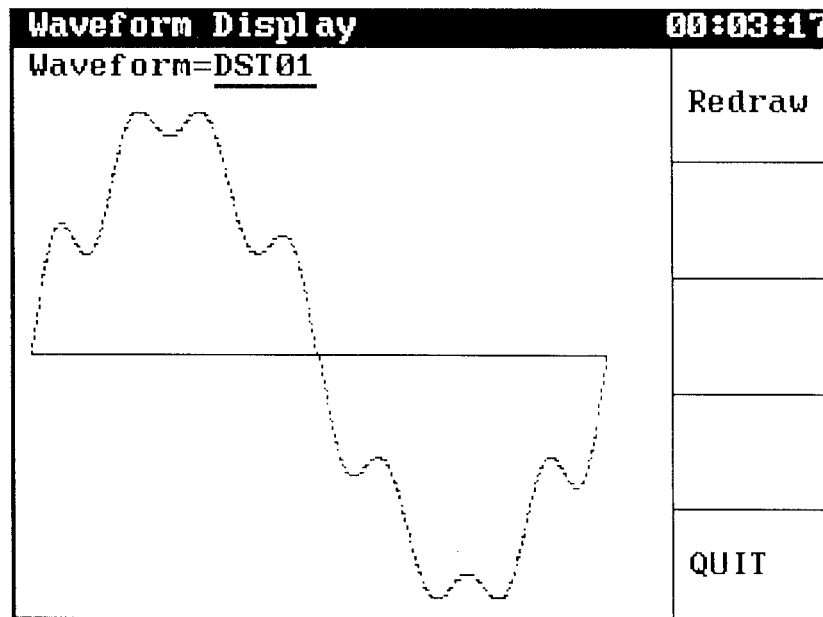
Full scale is automatically changed and displays on the heading of each waveform.

You can press **V** or **I** to view V or I, or **V+I** to view V and I at the same time. When everything is ready, press **QUIT** in the measurement display menu.

Note: The **WAVE** function is for the measured waveform $\emptyset 1$ only.

3.3.4 The View of the Stored Waveform

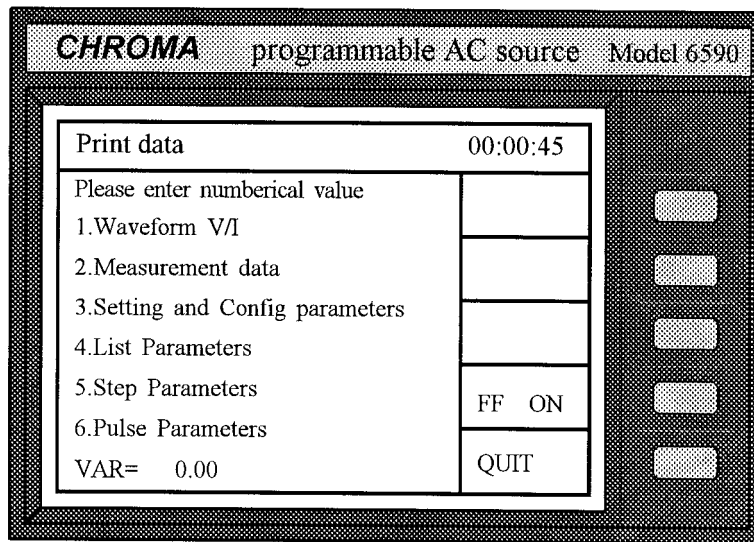
If you want to view the AC source stored waveform, you can press **VIEW** in the measurement display menu, and the LCD will show as follows:



Press **▲** or **▼** to select the waveform display, and press **Redraw** to update it. Press the soft key **□** to return to the measurement display menu.

3.3.5 The Printout

If you need the results of measurement, you can press **PRINT** in the measurement display menu, and select what you want, then press **ENTER** to start printing. "FF ON" means the form feed command will be executed when data printing finishes. Connect the printer to printer port on the rear panel. Press **QUIT** to return to the measurement display menu.



Note: The AC source supports HP LaserJet only.

3.4 Protection

The AC source provides protection for software and hardware. Protection for software is listed below:

Protection	Description
Current	When current is over the limit, protection is enabled.
Power	When power is over the limit, protection is enabled.
Voltage Limit	The voltage cannot be programmed more than the set voltage limit.
Voltage Range Error	During the operation of AC source, this message will be displayed when the set voltage is beyond the full scale of current voltage range.

Below lists the protection for hardware:

Protection	Description
PFO INT	It is power failure protection, and means the voltage of the power supply is lower than specification.
FAN INT	It is fan failure protection, and means the malfunction of cooling fan.
OPP INT	It is over power protection, and means the output stage is over the power specification.
OCP INT	It is over current protection, and means the output stage is over the current specification.
SHT INT	It is short protection, and means the output terminals are shorted.

INP	INT	It is power failure protection, and means the voltage of the input power supply is lower than specification.
OTP	INT	It is over temperature protection, and will be enabled when the AC source internal temperature is too high.
OPEN	INT	It is the feedback of open protection.
dV	INT	The protection happens when there is a big difference between the set voltage and the measured one.

If any output protection mentioned above is triggered to hold normal output, please resolve the errors, then press **ENTER**, and hold the key for two seconds to unlock the output protection so as to resume the normal operation.

4. Theory of Operation

4.1 General Information

The AC source consists of two (6560) or three (6590) power stages, and each stage has 13 PCBs (print circuit boards) and other components. Each of the PCBs has its specific functions that are described in the following section.

4.2 Description of Overall System

Figure 4-1 shows the overall system of each power stage. Main power flows through the A/D, D/D, and D/A power stage converter. The A/D power stage is designated as I board, and generates DC voltage from the line input. The DC voltage of A/D output is applied to the D/D input power stage. The G board of D/D stage takes power from the A/D output. It generates two isolated DC outputs for D/A power stage. The H board of D/A inverter generates AC output through full bridge controlled by C board to O board. The D/A power stage is through O board relays in parallel or series control to obtain more current and higher voltage.

A board is identified as CPU. The CPU of the AC source is used to perform the following work: remote control through GPIB, RS-232C or EXT VREF interface on Optional board, control output frequency and voltage through BS and C boards, measure voltage, current and power through BM board, display message, scan the front panel keys through LCD module and K board, and monitor all interrupts.

BM board is identified as the measurement unit. All measurement functions are performed here.

BS board is identified as the waveform generator. It generates output waveforms, which act as the reference input of C board.

C board is identified as the controller of DC to AC (H board). It controls DC to AC power stage in order to get the low distorted waveform output.

K board is identified as the keyboard along with RPG (Rotary Pulse Generator). It is an interface between user and the device when the latter is used in local operation.

Extended and Optional boards are identified as input/output signals, which include GPIB, RS-232C, EXT VREF, printer and other I/O control signals. Optional board is on Extended board.

M1 board is identified as motherboard that contains system power supply, fan control circuit, and interconnection of A, BM, BS, C boards.

M2 board is simply an interconnection of M1, Extended, and O boards.

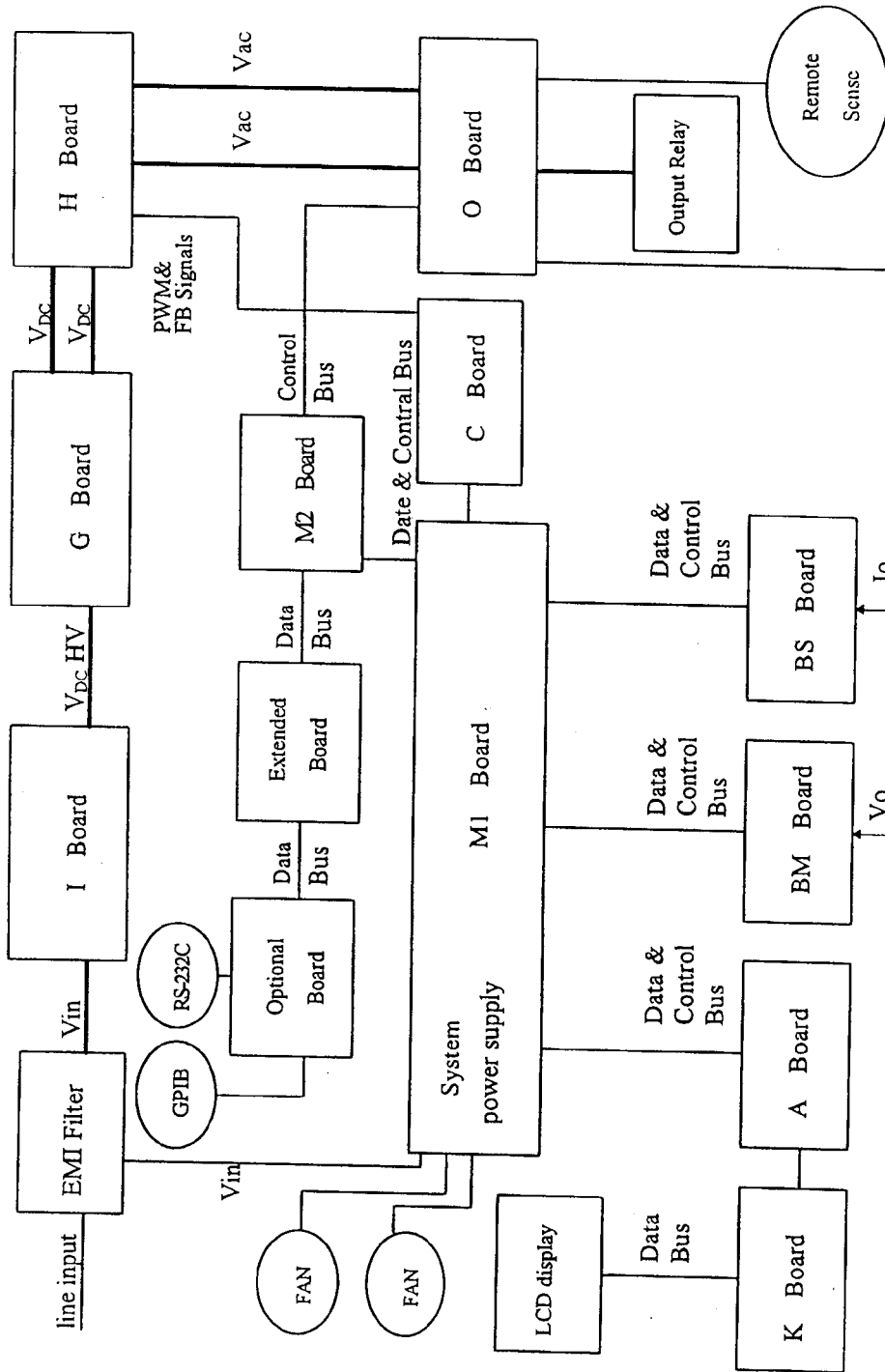


Figure 4-1 Block Diagram of Each Power Stage

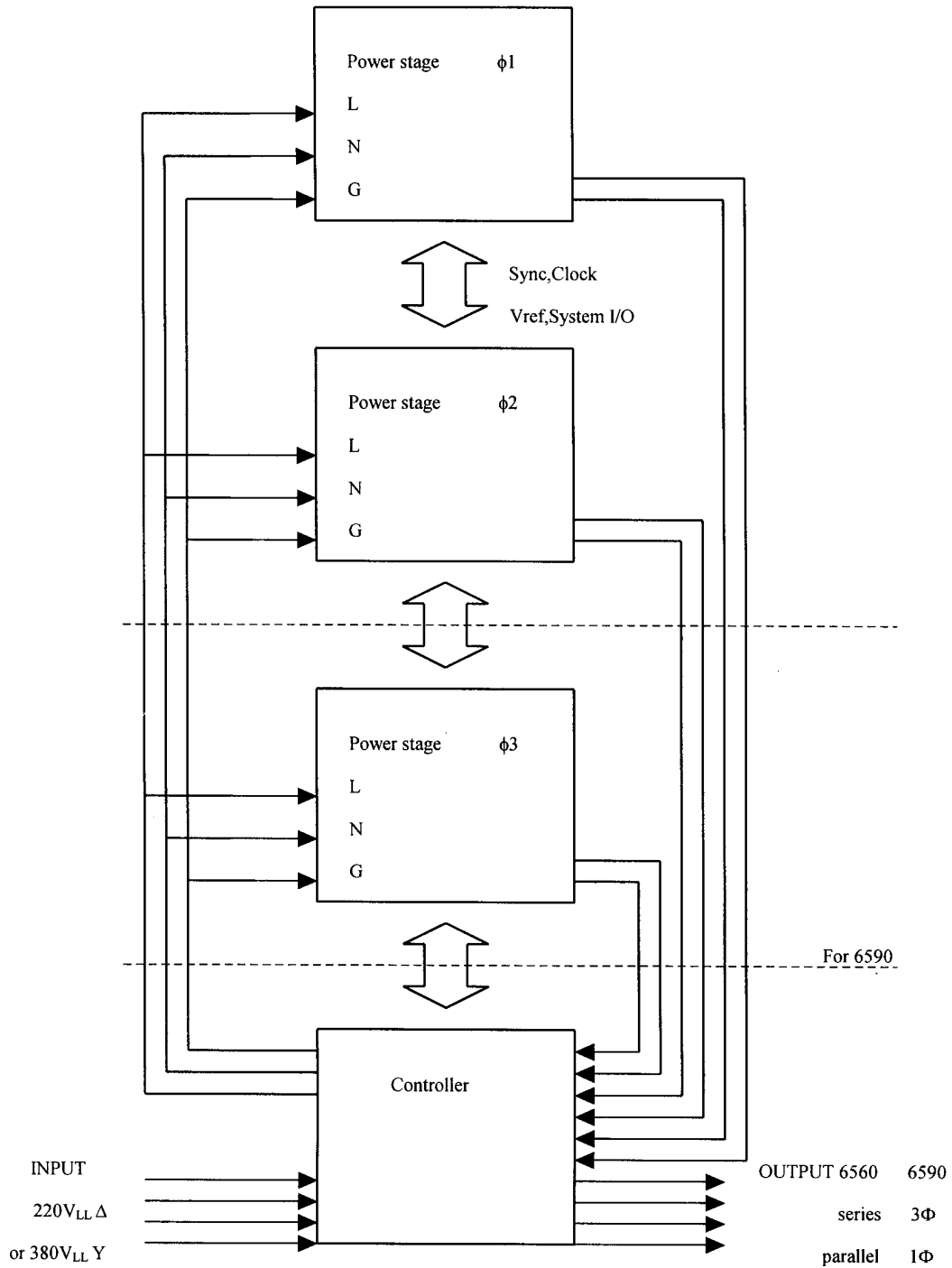


Figure 4-2 System Block Diagram

5. Calibration Procedure

This calibration procedure contains the information of performance calibration, adjustment, basic maintenance and error messages of the 6560/6590 AC source as well as the effective models of 6460/6463/6490. This chapter covers the information of fault isolation and board level calibration and is for trained service personnel only.

6560 and 6590 are composed of two plus three 6530s with a few differences inside so that they can be called master and slaves. The content of verification or calibration is described for 6530 only. For 6560 and 6590, verification can be done by measuring one phase at a time and the same for 6530 (or 6520 for 6463 only).

Calibration can be done by:

1. Separating 6560/6590 into master and slaves
2. Change them to 6530
3. Perform the same calibration steps as those of 6530 / 6520
4. Finally change them back to 6560 or 6590 master and slaves

WARNING

To avoid electric shock, do not perform any procedures described in this manual or do any servicing to the machine unless you are qualified to do so.

5.1 Required Test Equipment

The required test equipment is shown below.

Type	Required Characteristics
DMM	5 1/2 digits or more
Linear load	5.5 Ohm, 3KW (under 110 V)
Current shunt	Accuracy with 0.01A
40 pins ribbon cable	For connecting board K and Board A

NOTE

Board K pin 1 is connected to board A pin 40; Board K pin 2 is connected to board A pin 39, ... and so on. That is, the connectors of these two are reversed.

5.2 Verification

This section is about the test procedures to check the specification of each phase for Chroma AC source 6560/6590. By the following tests you can verify if the AC source operates properly without testing all of its functions. When performing verification, you should consider the uncertainty of instrument measurement.

5.2.1 Verification Test

WARNING

The AC source can supply 425 V peak or so at output. It may cause injury or death if the output terminals that connected to the load are touched when power is applied.

This test is to verify the voltage programming, the accuracy of voltage and current measurement function. Be sure to use the wire for size large enough to carry the maximum rated current of the supply when current verification is under way.

5.2.2 Voltage Programming & Measurement Accuracy

Procedures:

1. Turn off the AC source, and connect the DVM to the output terminals.
2. Turn on the AC source with no load
3. Select three phase mode for 6590/6490/6463 and series mode for 6560/6460, voltage range = AUTO on the output.
4. Set the current limit to its maximum value.
5. Program the output as a sine wave of 150V ($\varnothing 1 + \varnothing 2 + \varnothing 3$ for three phase), 60Hz.
6. Record the voltage reading at DVM and the display on the front panel.
7. Program the output to 300V.
8. Record the voltage reading at DVM and the display on the front panel.

Note: Phase voltage
6590/6490/6463: ($\varnothing 1$ - COM), ($\varnothing 2$ - COM), ($\varnothing 3$ - COM)
6560/6460: ($\varnothing 1$ - COM), ($\varnothing 2$ - COM)

5.2.3 Measurement Accuracy of Current

Procedures:

1. Turn off the AC source, and connect the current shunt of each phase (or one phase at a time if shunt is not enough) between the output terminals and the load.
2. Turn on the AC source, set voltage range to Auto, and program the output voltage =110V ($\varnothing 1 + \varnothing 2 + \varnothing 3$ for three phase). Set the current limit to its maximum value.
3. Record the current reading at shunt and the display on the front panel.

Parameters for Verification Test in each phase

Test Description	Minimum Spec.	Result	Maximum Spec.
Voltage Programming and Measurement of each phase			
Low Voltage (150V)	149.7		150.3
Display of AC source	Vout-500mV		Vout+500mV
High Voltage (300V)	299.4		300.6
Display of AC source	Vout-900mV		Vout+900mV
Current Measurement in each phase of 6590/6560/6490/6460			
Current (20A)		Iout	
Display of AC source	Iout-220mA		Iout+220mA
Current Measurement in each phase of 6463			
Current (20A)		Iout	
Display of AC source	Iout-230mA		Iout+230mA

If the verification results are not within the specifications, please refer to calibration procedures for adjustment.

5.3 Calibration

This section provides information of basic adjustment for 6560/6590 series AC source. They are composed of 6530 AC Source, so the calibration procedures below show how to change the 6560/6590 master and slaves to 6530 for the calibration procedures to be performed and then change them back.

5.3.1 6560/6590 master or slaves changes to 6530

This procedure includes H/W change and the front panel setting. The jumper status can change the H/W. You need to set the jumpers in the right side before setting master/slave and changing to 6530.

Procedures:

1. Remove all screws on the AC source rear rack and those of on the cover.
2. For slaves (Ø2 and Ø3) don't have the front panel, use a panel and a 40-pin ribbon cable to connect it to Board A.

① NOTE

Board K pin 1 is connected to board A pin 40; Board K pin 2 is connected to board A pin 39, ... and so on. That is, the connectors of these two are reversed.

3. Change the jumpers to 6530 jumper status:

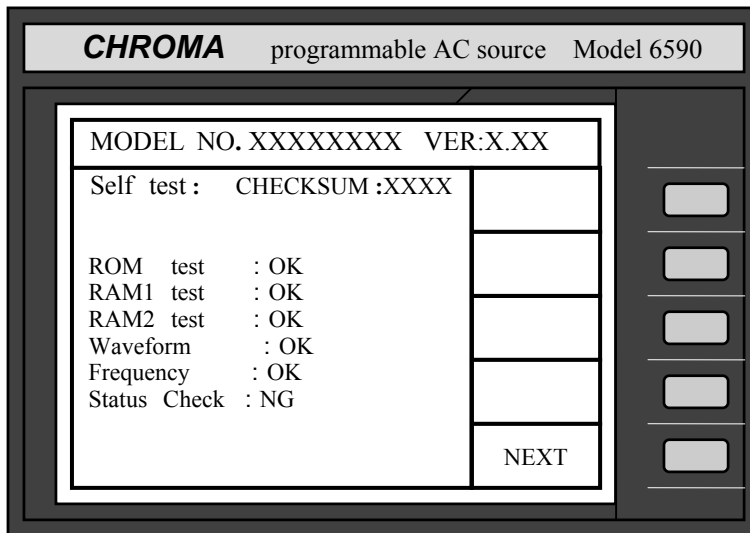
	Board BS JP5	Board M1 CN14	Board Extension		
			CN8	CN9	CN10
6530	SHORT	1,2 PINS SHORT	OPEN	OPEN	OPEN
6560 / 6460 Ø1	SHORT	1,2 PINS SHORT 3,4 PINS SHORT	SHORT	SHORT	OPEN
6590 Ø1	SHORT	1,2 PINS SHORT 3,4 PINS SHORT	SHORT	OPEN	SHORT
6463 Ø1	SHORT	1,2 PINS SHORT 3,4 PINS SHORT	OPEN	SHORT	SHORT
6560 / 6590 6460 / 6463 6490 Ø2	OPEN	2,4 PINS SHORT	OPEN	SHORT	OPEN
6590 / 6490 6463 Ø3	OPEN	2,4 PINS SHORT	OPEN	OPEN	SHORT

4. Insert the power cord to the input terminal first, and then plug the power cord into the mains to get power.

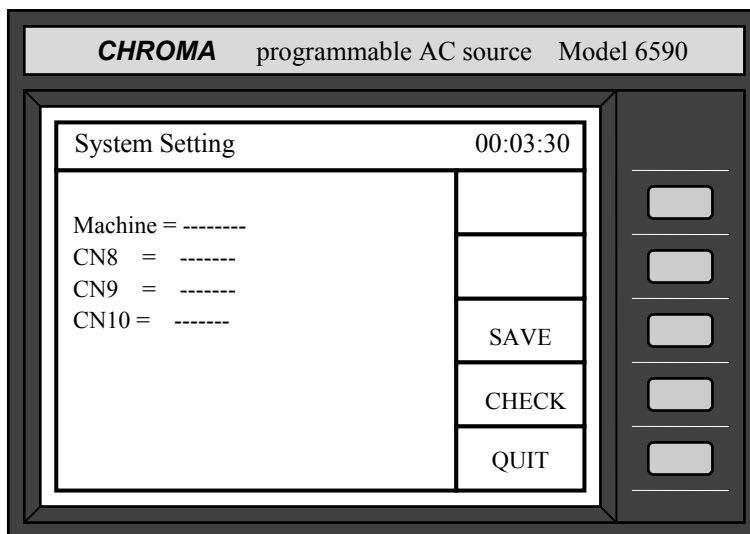
⚡ CAUTION

Master and slaves don't have power switch of their own, so the machine will turn on once you plug the power cord into the mains outlet.

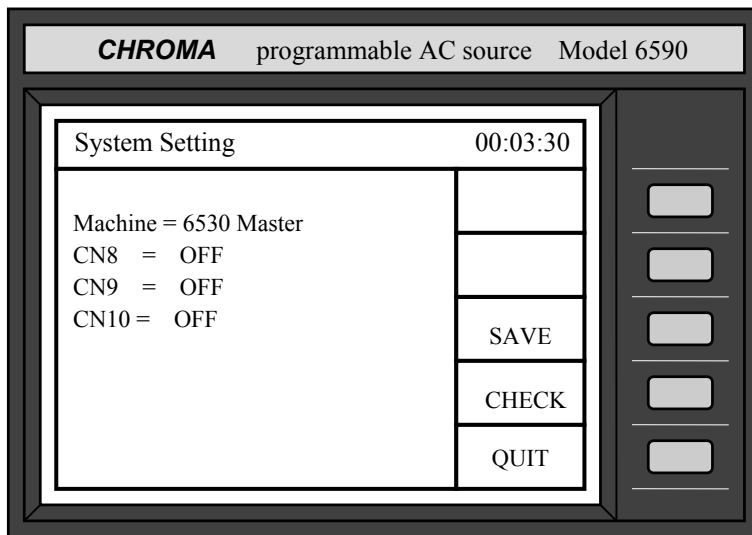
5. When the power is on, the display appears as below:



6. Press **0** and **7** simultaneously, and then press **next**, the display will go to the main page. Press **SET UP** to go to the SETUP page and then press **SYSset**, the following display will appear:



7. Press **CHECK** and the display will show the 6530 jumper status:



Press **SAVE** to change this machine to 6530 master.

Note: The jumper status: "OFF" means "OPEN"; "ON" means "SHORT".

8. Turn off the mains power and turn it on again, this machine now is changed to 6530.

5.3.2 Calibration procedures of 6530

This section provides the information of basic adjustment for 6530 series AC source. The verification tests contain a simple procedure that can check if the unit performs properly without testing all of the specified parameters.

After troubleshooting and repairs of a defective unit, you can also verify its operation with the adjustment procedure to ensure a good performance.

Press **CONF** in the main menu and **S-TEST** in the Configure Setting menu so as to get into the Software test plan menu. When **S-TEST** is pressed, the message "Disconnect output" will prompt on LCD to inform you the removal of loads.

WARNING

Some components and circuits are at AC line voltage despite that the line switch may be off. To avoid the hazard of electric shock, disconnect line cord as well as loads, and wait for 20 minutes before removing the cover.

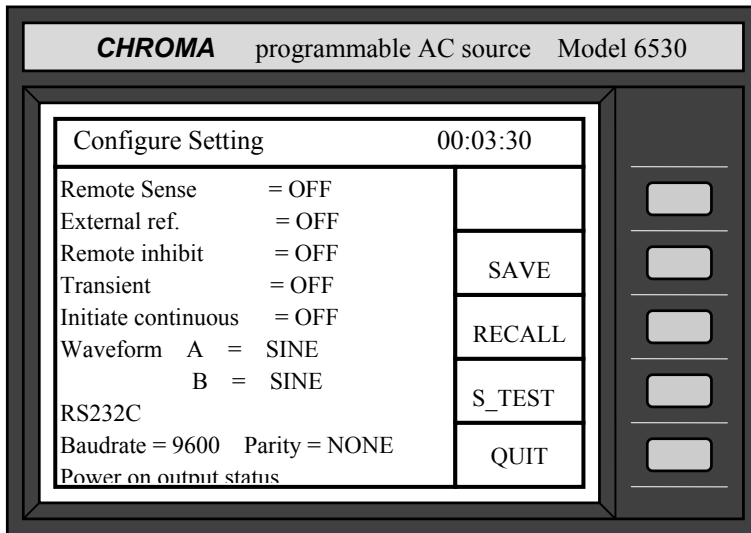


Figure 5-1 Configure Setting Menu

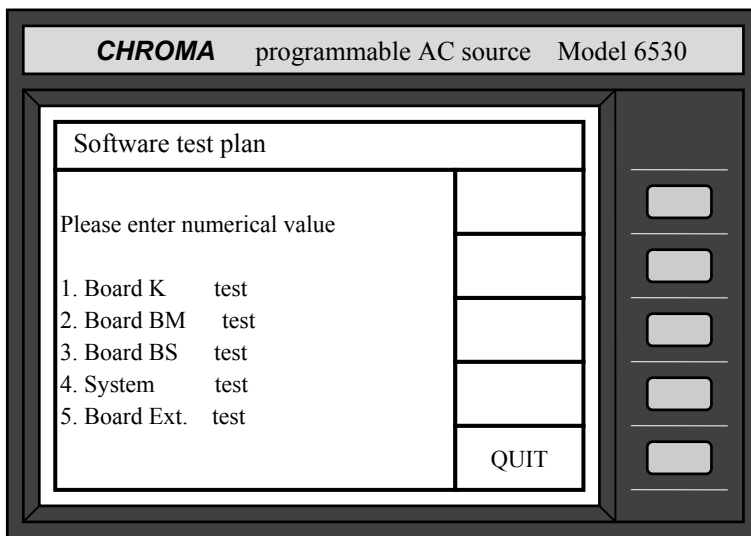


Figure 5-2 software test plan Menu

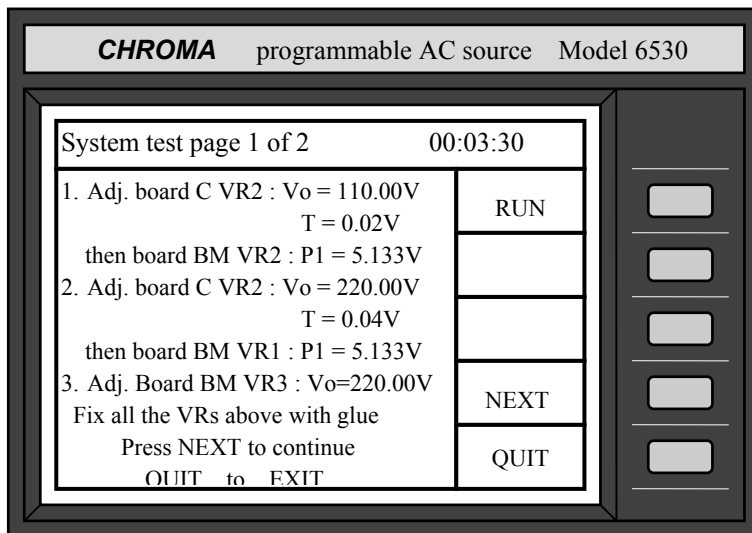


Figure 5-3 System test Menu, page 1 of 2

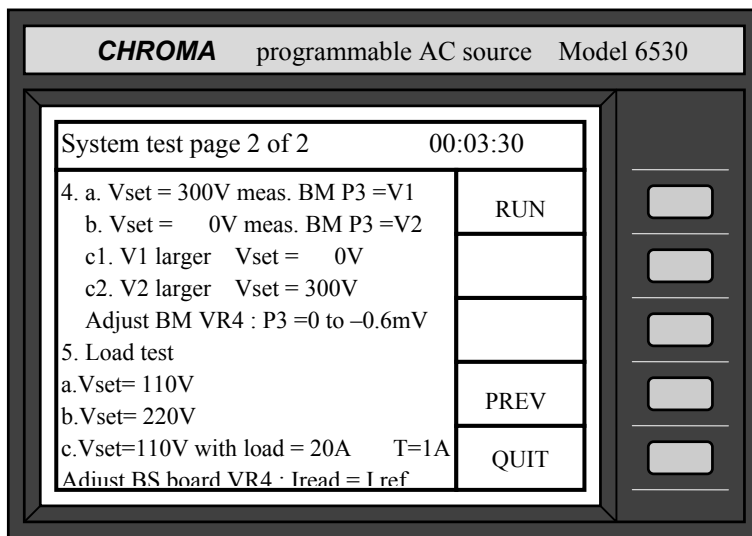


Figure 5-4 System test Menu, page 2 of 2

5.3.2.1 Reference Check & Adjustment of Voltage on BM Board

1. Set DMM at DC range to measure the test pin on P4 BM board.
DMM is low at AGND, and high at the test pin.
2. Trim VR5 to adjust the test pin P4 voltage to the range of $10.240 \pm 0.0004V$.
3. Trim VR6 to adjust the test pin P5 voltage to the range of $5.120 \pm 0.0002V$.

5.3.2.2 Adjustment of Output

This section describes the procedures of adjustment that verify the setting and measurement of the AC source output voltage, current and power. If the result of measurement is not accurate enough, you can calibrate it again following the procedures below.

5.3.2.3 Adjustment of Voltage

In Software test plan menu (Figure 4-2), Press **4** then **ENTER** to get into System test. Page 1 of 2 in System test appears on LCD (Figure 4-3), and the cursor stays at No. 1. Adjust the output voltage to 150V range.

1. Press **RUN** to enable output.
2. Set DMM at AC range to measure the output voltage.
Trim VR2 on C board to adjust the output voltage to the range of $110 \pm 0.02V$.
3. Move DMM to BM board test pin P1.
Trim VR2 to adjust P1 to the range of $5.133 \pm 0.001V$.

Move the cursor to No. 2 to adjust the output voltage to 300V range.

1. Press **RUN** to enable output.
2. Set DMM at AC range to measure the output voltage.
Trim VR2 on C board to adjust the output voltage to the range of $220 \pm 0.04V$.
3. Move DMM to BM board test pin P1.
Trim VR1 to adjust P1 to the range of $5.133 \pm 0.001V$.

Move the cursor to No. 3 to adjust the output voltage to 300V range with feedback.

1. Press **RUN** to enable output.
2. Set DMM at AC range to measure the output voltage.
Trim VR2 on C board to adjust the output voltage to the range of $220 \pm 0.04V$.

Thus, the adjustment of output voltage accuracy and output measurement accuracy is completed.

5.3.2.4 Adjustment of Power Measurement

Press **NEXT** to go to page 2 of 2 in System test menu; cursor will stay at No. 4a.

1. Press **RUN** to enable output.
2. Set DMM at DC range. Measure test pin P3 on BM board data=V1.
3. Move the cursor to 4b, and measure test pin P3 data=V2.

4. If $V1 > V2$, move the cursor to 4c1; otherwise, move the cursor to 4c2.
5. Press **RUN** and trim VR4 on BM board to adjust P3 to the range of $-0.3 \pm 0.3\text{mV}$.

5.3.2.5 Adjustment of Current Measurement

Move the cursor to No. 5a.

1. Connect the load to the output of AC source. Load resistance is about 22 Ohm.
2. Press **RUN** to enable output, and check output voltage for the range of $110 \pm 0.1\text{V}$.
3. Move the cursor to 5b, and change the load to 88 Ohm.
4. Press **RUN** to enable output, and check output voltage for the range of $220 \pm 0.2\text{V}$.
5. Move the cursor to 5c, and change the load to a desired value.
6. Connect shunt in series with the load, and press **RUN** to enable output.
7. Different models have their own adjusted current respectively.

Model	Ishunt	Power (minimum)
6530	$20 \pm 1\text{A}$	2400 W
6520	$13 \pm 1\text{A}$	1500 W

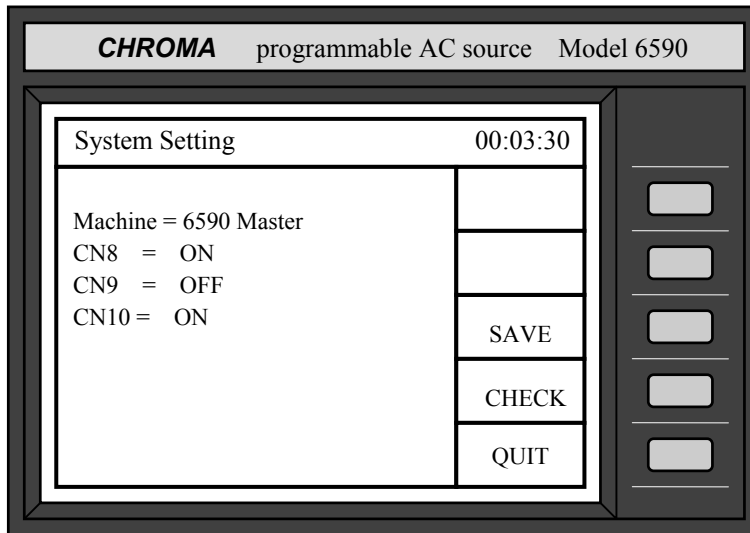
The reading of shunt current is Ishunt.

8. Trim VR4 on BS board to make the reading of AC source on LCD within the range of $I = \text{Ishunt} \pm 0.01\text{A}$. Thus, the adjustment of current measurement accuracy is completed.

5.3.3 6530 changes to 6560/6590 Master or Slave

The procedure is almost the same as section 5.4.1:

1. Change the Extension board jumpers back into 6590 (or other models) master or slaves status that is showed in the table of section 5.4.1. **Note:** Board BS and Board M1 jumpers are kept same as 6530.
2. Turn on the mains power by plugging in the power cord.
3. The display will show STATUS CHECK: NG. Press **0** and **7** simultaneously, and then press **next**, the display will go to the main page.
4. Press **SET UP** to go to the SETUP page and then press **SYSet**.
5. Press **CHECK** and the display will show the jumper status of extension board. For example: 6590 \emptyset 1.



Make sure the display shows the “machine” is the one you want to change back.

6. Press **SAVE** to save the machine you want, and then turn off the mains power.
7. Change the jumpers of BS board and M1 board to the one you want following the jumper status listed in the table of section 5.4.1.
8. Change the front panel back to its original one and screw down the cover.
9. Put them into the rack and assemble them to their original status. Then turn on the machine and make sure everything is OK by programming 300V voltage output.

5.4 Error Messages

The error messages that may appear on the LCD are listed below.

Protection on Display	Protection Full Name	Description
S.PROT	System protection (S/W)	The system generates this protection if any protection is generated or internal communication is jammed.
S.NP	Negative power protection (S/W)	The power value is less than -100W in 6560 or is the single-phase model.
S.DV	Differential voltage protection (S/W)	The difference between setting voltage and measured voltage is greater than 20V.
S.OPP	Over power protection (S/W)	The power value of phase ($\Phi 1, \Phi 2, \Phi 3$) is greater than 3060W. (For 6560/6590/6460/6490)
S.OCP	Over current protection (S/W)	The current value of phase ($\Phi 1, \Phi 2, \Phi 3$) is greater than the voltage limitation programmed.
FAN	Fan fail protection	Fan is out of order or its power supply is dead.

	(H/W)	
OPP	Over power protection (H/W)	Hardware over power signal enabled.
OCP	Over current protection (H/W)	It is generated if current value of any phase($\Phi 1, \Phi 2, \Phi 3$) is close to 31A.
PFO	Power failure protection (H/W)	+12V DC power source on A board is unstable.
OPEN	Open protection (H/W)	Program to output but there is no output voltage reading back.
OTP	Over temperature protection (H/W)	Temperature of phase($\Phi 1, \Phi 2, \Phi 3$) is too high.
SHT	Short protection (H/W)	The AC source output is shorted.
INP	Input power protection (H/W)	The input voltage of phase($\Phi 1, \Phi 2, \Phi 3$) is less than 190V.

6. Remote Operation

6.1 General Information

The AC source can be controlled remotely through the GPIB or the RS-232C port. The GPIB port is mostly used, however the RS-232C port is also pretty helpful.

Technically speaking, the GPIB interface is quite different from the RS-232C interface. The GPIB interface is an 8-bit parallel data bus having a host of bus commands for synchronization, and up to one Megabyte data transfer rate. The RS-232C interface, a series bus with a few handshake lines for synchronization, is less capable, thus its requirement is less. You can write a simple program to do the basic remote control easily.

6.1.1 Setting the GPIB Address and RS-232C Parameters

The AC source is shipped with the GPIB address, which is set to 30. The address can only be changed from the front panel by pressing **CONFIG** in the “Configure Setting” menu. This menu can also used to select the RS-232C interface, and specify its parameters such as baud rate and parity.

Set the GPIB address as follows:

1. Press **CONFIG** to enter into the “Configure Setting” menu.
2. Move the cursor to the line of GPIB address.

GPIB address =30

3. Enter the new address number such as **5** and press **ENTER**. The GPIB address changes to 5.

GPIB address =5

Set the RS-232C interface as follows:

1. Press **CONFIG** to enter into the “Configure Setting” menu.

2. Move the cursor to RS-232C parameters of baud rate.

Baudrate= <u>4800</u> Parity=EVEN

3. Select baud rate by pressing ▲ or ▼, and press **ENTER**.
4. Move the cursor to the line of parity, and select parity.

6.1.2 Wire Connection of RS-232C

The AC source is shipped with the baud rate set to 9600 and parity set to None. For RS-232C interface, only the signals of TxD, RxD, are used for data transfer. The RS-232C connector is a 9-pin D subminiature female connector. Following table describes the pins and signals of RS-232C connector.

Pin No.	Input/Output	Description
1	---	No connection
2	OUTPUT	TxD
3	INPUT	RxD
4	---	DSR
5	---	GND
6	---	DTR
7	---	CTS
8	---	RTS
9	---	No connection

Interconnection between the computer (compatible with IBM PC) and AC source is illustrated below:

PIN	IBM PC	AC source
1	DCD	X
2	RX →	TX
3	TX →	RX
4	DTR	X
5	GND —	GND
6	DSR	X
7	RTS	X
8	CTS	X
9	RI	X

6.2 The GPIB Capability of the AC Source

GPIB Capability	Description	Interface Functions
Talker/Listener	Commands and response messages can be sent and received over the GPIB bus. Status information can be read using a series poll.	AH1, SH1, T6, L4
Service Request	The AC source sets the SRQ line true if there is an enabled service request condition.	SR1
Remote/Local	The AC source powers up in local state. In local state, the front panel is operative, and the AC source responds to the commands from GPIB. In remote state, all front panel keys except the local key are disabled. Press local key to return the AC source to local state. Local key can be disabled using local lockout so that only the controller or the power switch can return the AC source to local mode.	RL1

6.3 Introduction to Programming

All commands and response messages are transferred in the form of ASCII codes. The response messages must be read completely before a new command is sent, otherwise the remaining response messages will be lost, and a query interrupt error will occur.

6.3.1 Conventions

Angle brackets	< >	Items in angle brackets are parameter abbreviations.
Vertical bar		Vertical bar separates alternative parameters.
Square brackets	[]	Items in square brackets are optional. For example, OUTP [: STATE] indicates that : STATE may be omitted.
Braces	{ }	Braces indicate the parameters may be repeated. The notation <A> {<, B>} means parameter "A" must be entered while parameter "B" may be omitted or entered once or more times.

6.3.2 Numerical Data Formats

All data programmed to or returned from the AC source are ASCII. The data can be numerical or character strings.

Numerical Data Formats

Symbol	Description	Example
NR1	It is a number with no decimal point. The decimal is assumed to be at the right of the least significant digit.	123, 0123
NR2	It is a number with a decimal point.	12.3, .123
NR3	It is a number with a decimal point and an exponent.	1.23E+2

6.3.3 Boolean Data Format

The Boolean parameter <Boolean> uses the form ON|OFF only.

6.3.4 Character Data Format

The character strings returned by query command may in the following two forms:

- <CRD> Character Response Data: character string with maximum length of 12.
- <SRD> String Response Data: character string.

6.3.5 Basic Definition

Command Tree Table:

The commands of AC source are based on a hierarchical structure, which is also known as a tree system. In order to obtain a particular command, the full path to the command must be specified. This path is represented in the table by placing the highest node in the farthest left of the hierarchy. Lower nodes in the hierarchy are indented at the right below the parent node.

Program Headers:

Program headers are the key words to identify the command. They follow the syntax described in IEEE 488.2 section 7.6. The AC source accepts characters in both upper and lower case

without distinction. Program headers consist of two distinctive types, common command headers and instrument-controlled headers.

Common Command and Query Headers:

The syntax of common command and query headers is described in IEEE 488.2. It is used with the IEEE 488.2-defined common commands and queries. The commands with a leading “ * ” are common commands.

Instrument-Controlled Headers:

Instrument-controlled headers are used for all other instrument commands. Each of them has a long form and a short form. The AC source accepts the exact short and long forms only. A special notation will be taken to differentiate the short form header from the long one of the same header in this section. The short form of the header is shown in upper case characters, whereas the rest of the header are shown in lower case.

Program Header Separator (:):

If a command has more than one header, you must separate them with a colon (FETC:CURR FUNC:SHAP). Data must be separated from program header by one space at least.

Program Message:

Program message consists of a sequence of zero or more elements of program message unit that is separated by separator elements.

Program Message Unit:

Program message unit represents a single command, programming data, or query.

Example: VOLT?, OUTPut ON.

Program Message Unit Separator (;)::

The separator (semicolon ;) separates the program message unit elements from one another in a program message.

Example: VOLT 110 ; FREQ 120<PMT>

Program Message Terminator (<PMT>):

A program message terminator indicates the end of a program message. Three permitted terminators are:

(1) <END> : end or identify (EOI)

- (2) <NL> : new line which is a single ASCII-encoded byte 0A (10 decimals).
- (3) <NL> <END> : new line with EOI.

Note: The response message is terminated by <NL> <END> for GPIB, and <NL> for RS-232C.

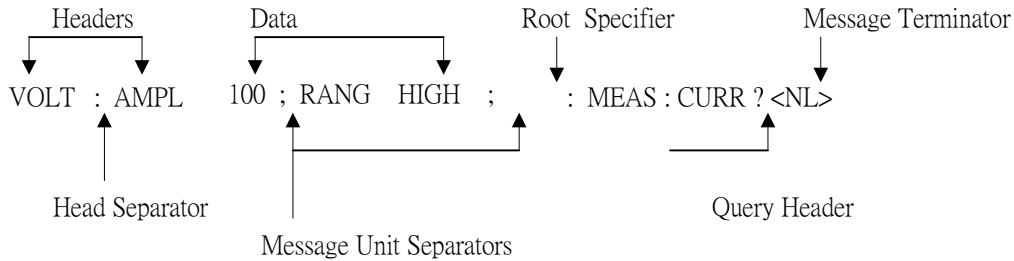


Figure 6-1 The Structure of Command Message

6.4 Traversal of the Command Tree

Multiple program message unit elements can be sent in a program message. The first command is always referred to the root node. Subsequent commands are referred to the same tree level as the previous command in a program message. A colon preceding a program message unit changes the header path to the root level.

Example:

OUTPut : PROTection : DELAY 1	All colons are header separators.
: OUTPut : PROTection : DELAY 1	Only the first colon is a specific root.
OUTPut : PROTection : DELAY 1; : VOLT 100	Only the third colon is a specific root.

6.5 Execution Order

The AC source executes program messages by the order received. Program message units except coupled commands are executed in order of reception. The execution of coupled commands is deferred until the program message terminator is received. A coupled command sets the parameters that are affected by the setting of other commands. Problems may arise as the AC source prior state will affect the response of a coupled parameter to its programming.

For example, assuming the current output voltage range is LOW, a new state of output voltage range is HIGH, and amplifies to 220 Volt. If the commands

```
VOLTage 220<PMT>
RANGe HIGH<PMT>
```

are sent, the error of data out of range will be generated. Reversing the order, or sending the commands in one program message can avoid such kind of error. For the above example, the program message below

```
VOLTage 220 ; RANGe HIGH<PMT>
```

can be sent without error.

The following commands are coupled: VOLTage, : RANGe.

6.6 The Commands of the AC Source

This section covers the syntax and parameters for all commands of the AC source. The examples given for each command are generic.

Syntax Forms	Definitions of syntax are in long form headers, while only short form headers appear in the examples.
Parameters	Most commands require a parameter, and all queries return a parameter.
Models	If a command is merely applied to specific models, these models will be listed in the Model only entry. If there is no Model only entry, the command will be applied to all models.

6.6.1 Common Command Dictionary

Common commands begin with a “ * ”, and consist of three letters and/or one “ ? ” (query). Common commands and queries are listed alphabetically.

*CLS Clear status

This command clears the following registers

- (1) Questionable Status Event
- (2) Status Byte
- (3) Error Queue

*ESE<n> Standard event status enabled

This command programs the Standard Event register bits. If one or more enabled

events of the Standard Event register is set, the ESB of Status Byte Register is set too.

Bit Configuration for Standard Event Status Enabled Register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	- - -	CME	EXE	DDE	QYE	- - -	OPC
CME = Command error				DDE = Device-dependent error				
EXE = Execution error				OPC = Operation complete				
PON = Power-on				QYE = Query error				

*ESE? Return standard event status enabled

The query reads the Standard Event Status Event register. Reading of the register clears it. The bits of configuration are the same as Standard Event Status Enabled Register.

*IDN? Return the AC source identification

Return Parameter Chroma ATE 6530, 1234, 2.01
 Chroma ATE : Company name
 6530 : Model number
 1234 : Serial number
 2.01 : Firmware version number

*RCL<n> Restore the values of a specific group that is previously stored in memory.

Parameter 0 - 2

*SAV<n> Save the values into a specific group in memory.

Parameter 0 - 2

6.6.2 Instrument Command Dictionary

The commands are listed in alphabetical order. Commands followed by question marks (?) are the query forms. When commands in both command and query forms, they are noted in the syntax descriptions.

FETCh | MEASure

[: SCALar]

: CURRent

: AC?

Query the AC rms current

: AMPLitude : MAXimum?

Query the peak current

: CRESfactor?

Query the current crest factor

This command lets you get the measurement data from AC source. Two measurement commands are available: MEASure and FETCh. MEASure triggers the acquisition of new data before returning data. FETCh returns the previously acquired data from the measurement buffer. Individual outputs of a multi-phase source are specified by INSTRument : NSElect command.

FETCh [: SCALar] : CURRent : AC?**MEASure [: SCALar] : CURRent : AC?**

Return parameters <NR2>

These queries return the rms current, which is being output at the output terminal.

FETCh [: SCALar] : CURRent : AMPLitude : MAXimum?**MEASure [: SCALar] : CURRent : AMPLitude : MAXimum?**

Return parameters <NR2>

These queries return the absolute value of peak current.

FETCh [: SCALar] : CURRent : CRESfactor?**MEASure [: SCALar] : CURRent : CRESfactor?**

Return parameters <NR2>

These queries return the output current crest factor. It is the ratio of peak output current to rms output current.

FETCh [: SCALar] : CURRent : INRush?**MEASure [: SCALar] : CURRent : INRush?**

Return parameters <NR2>

These queries return the value for inrush current.

These queries return the reactive power, which is being output at output terminals in volt-amperes. Reactive power is computed as:

$$\text{VAR} = \sqrt{\text{APPARENTPOWER}^2 - \text{REALPOWER}^2}$$

FETCh [: SCALAr] : POWer : AC : PFActor?
MEASure [: SCALAr] : POWer : AC : PFActor?

Return parameters <NR2>

These queries return the power factor, which is being output at output terminals. Power factor is computed as:

PF = TRUE POWER / APPARENT POWER

FETCh [: SCALAr] : POWer : AC : TOTal?
MEASure [: SCALAr] : POWer : AC : TOTal?

Return parameters <NR2>

For model 6590/6560 only.

These queries return the total true power, which is being output at output terminals in watts.

FETCh | MEASure

[: SCALAr]

: VOLTage

: AC?

Query the output voltage

Return parameters <NR2>

FETCh [: SCALAr] : VOLTage : AC?
MEASure [: SCALAr] : VOLTage : AC?

These queries return the ac rms voltage, which is being output at the output terminals.

INITiate

[: IMMEDIATE]

: CONTinuous

: SEquence1 ON | OFF

INITiate [: IMMEDIATE]

The INITiate commands control the initiation of the transient generator trigger system. Commands change the trigger system from idle state to waiting-for-trigger state.

INITiate : CONTInuous : SEQuence1 ON | OFF

This command controls the transient generator trigger system.

ON continuously initiates the transient trigger system.

OFF turns off triggering continuously. In this state, you must initiate each trigger using INITiate : SEQuence1.

INSTrument

: COUPlE ALL NONE	Set coupled phases for programming
: NSELEct <n>	Select output phase to program
: SELEct <OUTPut>	

For model 6590 only.

INSTrument : COUPlE ALL | NONE

Query syntax	INSTrument : COUPlE?
Return parameters	ALL NONE

In a multi-phase power source it is convenient to set parameters for all phases simultaneously with one programmed command. When INST : COUP ALL command is programmed, a command will be sent to the AC source, and to all phases in the end. INST : COUP NONE command cancels COUP ALL command. This command affects the set voltage only.

This command has no effect on queries and is able to set parameters only.

INSTrument : NSELEct 1 | 2 | 3

INSTrument : SELEct OUTPut1 | OUTPut2 | OUTPut3

Query syntax	INSTrument : NSELEct?
Return parameters	1 2 3

This command sets individual outputs in a multi-phase model for subsequent commands or queries. If INST : COUP NONE is programmed, the phase-selective commands are sent to the particular output phase set by INSTrument : NSELEct. If INST : COUP ALL is programmed,

all commands are sent to all output phases. This command affects the set voltage and queries Measurement data. For example, if “INST : COUP ALL ”, “INST : NSEL 2” and “Meas : V?” are programmed, the AC source will return Ø2’s measured voltage. INST : NSEL selects phase by number, and INST : SEL refers to it by name.

ORELay ON | OFF Set output relay on (closed) or off (open)

This command sets output relay on/off.

ON sets the output relay of the AC source on (closed).

OFF sets the output relay of the AC source off (open).

OUTPut

[: STATE] <bool> Enable/disable the output of AC source

: PROTection

: CLear Reset protection status

: DELay <n> Set the delay time of protection

OUTPut [: STATE] ON | OFF

Query syntax OUTPut?

Return parameters ON | OFF

This command enables or disables the output of AC source. Disable output is to set an output voltage amplitude at 0 Volt.

OUTPut : PROTection : CLear

This command clears the latch that disables the output when a condition of over current (OC), over temperature (OT), overpower (OP) or remote inhibit (RI) is detected. All conditions that generate the fault must be removed before the latch is cleared.

OUTPut : PROTection : DELay <NR2>

Query syntax OUTPut : PROTection : DELay?

Parameter 0.0 to 100.0

Return parameters <NR2>

This command sets delay time when software protection occurs. The time unit is 0.1 second.

RANGe HIGH | LOW Set the output voltage range

Query syntax RANGE?
Parameter HIGH | LOW
Return parameters HIGH | LOW

This command sets the output voltage range of AC source.

HIGH sets the AC source to 300V (high) range.

LOW sets the AC source to 150V (low) range.

[SOURce :]

CURRent

[: LEVel]

[: IMMEDIATE]

[: AMPLitude] <n> Set the rms current limit

[SOURce :] CURRent [: LEVel] [: IMMEDIATE] [: AMPLitude] <NR2>

Query syntax CURRent [: LEVel] [: IMMEDIATE] [: AMPLitude] ?
Parameter 0.00 to 100.00
Return parameters <NR2>

This command sets the rms current limit of AC source for software protection. The unit is 0.01 ampere.

[SOURce :]

FREQuency

[: CW | : IMMEDIATE] <n>

Set the output frequency

[SOURce :] FREQuency [: CW | : IMMEDIATE] <NR2>

Query syntax [SOURce :] FREQuency [: CW | : IMMEDIATE] ?
Return parameters <NR2>

The command sets the frequency of the AC source output waveform.

[SOURce :]

FUNction

: SHAPe

: A | B

Select the active waveform buffer

[<shape>]

Set the waveform buffer shape

[SOURce :] FUNCtion : SHAPe A | B

Query syntax [SOURce :] FUNCtion : SHAPe?
 Return parameters A | B

This command sets the active buffer of waveform generator. There are two waveform buffers. One is A and another is B. You can select active buffer using FUNC : SHAP A | B command.

[SOURce :] FUNCtion : SHAPe : A | B <shape>

Query syntax [SOURce :] FUNCtion [: SHAPe] [: A | B]?
 Return parameters SIN| SQU| CSIN| DST<1. .30>| US<1. .6>

This command specifies the waveform buffer. There are two buffers for the AC source output. You need to specify the contents of waveform buffer A or B for AC source.

<shape>

SINusoid	Sine waveform output
SQUare	Square waveform output
DST <n>	Distorted waveform output 1-30
CSINusoid <n>	% of peak where the clipped sine (or % THD) is
US <n>	User-defined waveform output 1-6

The clipping level is expressed as a percentage of the peak amplitude when clipping occurs. Range is from 0 to 100 percent. These are the default units when the optional THD suffix is not sent. If the THD suffix is sent, the range will be from 0 to 43 percent. The maximum peak voltage that AC source can output is 425V peak. Therefore, the maximum rms value can be programmed depends on the peak to rms ratio of selected waveform. Refer to *Appendix F* for non-sine wave maximum programmed voltage.

[SOURce :] FUNCtion : TRANSient ON | OFF

Query syntax [SOURce :] FUNCtion :TRANSient?
 Return parameters ON/OFF

This command sets transient option.

[SOURce :]
 VOLTage
 [: LEVel]

[: IMMEDIATE]
 [: AMPLITUDE] <n> Set the rms voltage amplitude

[SOURCE :] VOLTage [: LEVEL] [: IMMEDIATE] [: AMPLITUDE] <NR2>

Query syntax VOLTage [: LEVEL] [: IMMEDIATE] [: AMPLITUDE]?
 Return parameters <NR2>

This command sets the rms output voltage level of AC source.
 This command is programmed to change the setting value only. But it does not output until "OUTP ON" is programmed.

V <NR2>

This command sets the AC Source output value immediately.

There is No Query command.

SYSTEM

: ERRor? Query the error string

Response error strings:

No Error	Data Format Error	Data Range Error
Too Many Errors	Execution Error	

TRACe | DATA

[: DATA] <US1, . . . , US6>, <D1, D2. . .> Assign value to a waveform

These commands set the value of user-defined waveform table. The first parameter is the waveform of No.1 to 6 and follows by 1000 data points. They define the relative amplitudes exactly one cycle of the waveform. The first data point defines the relative amplitude that outputs at 0 degree phase. An error will occur if there are not exactly 1000 data points being sent with the command.

Data points should be in range of 0 to 4095 so as to meet the correct rms value. The data should meet the following requirements:

- 1: $D1+D2+. . . +D1000 = 1000 \times 2048$
- 2: $(D1-2048)^2 + (D2-2048)^2 + . . . + (D1000-2048)^2 = 500 \times (2048)^2$

The first requirement is to set the average value at the middle of 0 to 4095. The second requirement is to get the rms value.

The size of receiver buffer in the AC source is 1000 byte, so when data are downloaded to the

AC source, time limit must be long enough for AC source to process the data. The time limit should be at least 20 seconds for multi-phase (Model 6560/6590) system.

Waveform data is stored in battery back-up RAM, and retained when input power is removed.

TRIGger

```
[ : SEQuence1 | : TRANsient]
  [ : IMMEDIATE]
```

This command controls the triggering of AC source in execution MODE. When MODE command is executed, INITiate command must be sent to AC source to initialize the transient trigger system. TRIGger command follows INIT to trigger AC source.

TRIGger [: SEQuence1 | : TRANsient] [: IMMEDIATE]

After the trigger status has been initiated, the TRIGger command will generate a trigger signal.

TPHase <NR2> Set transient phase angle

Query syntax	TPHase?
Parameter	0.0 to 359.99
Return parameters	<NR2>

This command sets the transient phase of AC source.

TPHase:SYNC IMM | SYNC

Query syntax	TPHase:SYNC?
Return parameters	IMM PHAS

When “TPH:SYNC IMM” is programmed, the transient phase is random. If ”TPH:SYNC PHAS” is programmed, the transient phase is output according to the transient phase angle.

NPHase SINGLE | THREE (6590)

NPHase PARALLEL | SERIES (6560)

This command switches SINGLE / THREE relay. Output must be off before programming.

```
[SOURce:]
  LIST
    :COUNT <n> | INFINITY
```

```

: SYNC IMMEDIATE | PHASE
: SPHase
: QUIT
: BASE TIME | CYCLE
: DWEL <n>{, <n>}
: POINTS?
: FREQUENCY [: LEVEL] <n>{, <n>}
: POINTS?
: VOLTAGE [: LEVEL]
: START <n>{, <n>}
: POINTS?
: END <n>{, <n>}
: POINTS?
: SHAPE A | B {, A | B}
: POINTS?
: START <n>{, <n>}
: END <n>{, <n>}
: LOOP <n>{, <n>}
: STEPNO <n>{, <n>}

```

LIST : COUNT <NR1> | INFINITY

This command sets the number of times for executing LIST. Use INFINITY to execute a LIST indefinitely.

Query Syntax	[SOURCE :] : LIST : COUNT?
Parameter	1 to 60000
Return parameters	<NR1> INFINITY

LIST : SYNC IMMEDIATE | PHASE

LIST : SYNC IMM Change the AC source output transient phase immediately to LIST mode.

LIST : SYNC PHASE Change the AC source output transient phase synchronously to LIST mode.

Query Syntax	[SOURCE :] : LIST : SYNC?
Parameter	IMM PHAS
Return parameters	IMM PHAS

LIST : SPHase <NR2>

This command sets the phase of the output voltage waveform in LIST mode.

Query Syntax	[SOURCE :] : LIST : SPHase?
--------------	------------------------------

Parameter	0 to 359.99
Return parameters	<NR2>

LIST: QUIT

This command interrupts the running LIST.

LIST : BASE TIME | CYCLE

This command sets the time base in LIST mode.

Query Syntax	[SOURCE :] : LIST : BASE?
Parameter	TIME CYCLE
Return	TIME CYCLE

LIST : DWEL <NR2>{, <NR2>}

This command sets the sequence of LIST dwell time. Each value represents the time in second. The output will stay at the LIST sequence before completion. Notice that you must select the base of time (LIST: BASE TIME | CYCLE) before sending the command.

Query Syntax	[SOURCE :] : LIST : DWEL?
Parameter	0 second to 999999 ms (Time base) 0 cycle to 6000.0 cycles (Cycle base)
Return parameters	<NR2>

LIST : DWEL : POINT? <NR1>

This query returns the number of points specified in LIST: DWEL. The returned value is the total number of points.

Return parameters	<NR1>
-------------------	-------

LIST : FREQUENCY [: LEVEL] <NR2>{, <NR2>}

This commands sets the frequency sequence. The frequency points are given in the command parameter, which are separated by comma or space.

Query Syntax	[SOURCE :] : LIST: FREQUENCY?
Parameter	15.00 to 2000.00
Return parameters	<NR2>

LIST : FREQUENCY [: LEVEL] : POINT?

This query returns the number of points specified in LIST: FREQ. The return value is the total number of points.

Return parameters <NR1>

LIST : VOLTage [: LEVel] : START <NR2>{, <NR2>}

This commands sets the sequence of beginning voltage. The beginning voltage points are given by command parameters that are separated by comma or space.

Query Syntax	[SOURce :] : LIST: VOLTage: START?
Parameter	0.0 to 300.0
Return parameters	<NR2>{, <NR2>}

LIST : VOLTage [: LEVel] : START : POINT?

This query returns the number of points specified in LIST: VOLTage [: LEVel] : START. The return value is the total number of points.

Return parameters <NR1>

LIST : VOLTage [: LEVel] : END <NR2>{, <NR2>}

This command sets the sequence of the ending voltage. The ending voltage points are given in by command parameters that are separated by comma or space.

Query Syntax	[SOURce :] : LIST: VOLTage: START?
Parameter	0.0 to 300.0
Return parameters	<NR2>{, <NR2>}

LIST : VOLTage [: LEVel] : END : POINT? <NR1>

This query returns the number of points specified in LIST: VOLTage [: LEVel] : END. The return value is the total number of points.

Return parameters <NR1>

LIST : SHAPe A | B{, A | B}

This command sets the sequence of shape. The shape points are given by command parameters that are separated by commas or space. There are two waveform buffers, A and B. You can select an active buffer through FUNC: SHAP A | B command.

Query Syntax	[SOURCE :] : LIST : SHAPe?
Parameter	A B
Return parameters	A B{, A B}

LIST: SHAPe: POINT?

This query returns the number of points specified in LIST: SHAPe. The return value is the total number of points.

Return parameters	<NR1>
-------------------	-------

LIST : START <NR1>{, <NR1>}

This command sets the sequence of the starting sequence in LOOP SETUP. These parameters are separated by comma or space.

Query Syntax	[SOURCE :] : LIST : START?
Parameter	0 to 39
Return parameters	<NR1>{, <NR1>}

LIST : END <NR1>{, <NR1>}

This command sets the sequence of the ending sequence in LOOP SETUP. These parameters are separated by commas or space.

Query Syntax	[SOURCE :] : LIST : END?
Parameter	0 to 39
Return parameters	<NR1>{, <NR1>}

LIST : LOOP <NR1>{, <NR1>}

This command sets the sequence of loop cycles. The loop means the number of times it is executed from the starting sequence to end.

Query Syntax	[SOURCE :] : LIST : LOOP?
Parameter	0 to 9999
Return parameters	<NR1>{, <NR1>}

LIST : STEPno <NR1>

This command sets how many steps are executed in a sequence.

Query Syntax	[SOURCE :] : LIST : STEPno?
Parameter	0 to 999

Return parameters <NR1>{, <NR1>}

[SOURce :]

: STEP

: SYNC IMMEDIATE | PHASe
 : SPHase<n>
 : VOLTage <n>
 : FREQuency <n>
 : SPHase <n>
 : SHAPe <n>
 : DVOLTage <n>
 : DFRequency <n>
 : DWELL <n>
 : COUNT <n>

STEP : SYNC IMMEDIATE | PHASe

If STEP : SYNC PHASe is programmed, the AC source will synchronize the specified phase angle to output voltage in PULSE mode. The phase angle will be neglected if STEP: SYNC IMM is programmed.

Query Syntax [SOURce :] : STEP : SYNC?
 Parameter PHASe | IMMEDIATE
 Return parameters PHAS | IMM

STEP : SPHase <NR2>

If STEP : SPHase 90 is programmed, the AC source will not output the specified voltage until 90 degree is met. This command is invalid when STEP: SYNC IMM is programmed.

Query Syntax [SOURce :] : STEP : SPHase?
 Parameter 0.00 to 359.99
 Return parameters <NR2>

STEP : VOLTage <NR2>

This command sets the initial voltage.

Query Syntax [SOURce :] : STEP : VOLTage?
 Parameter 0.0 to 300.0
 Return parameters <NR2>

STEP : FREQuency <NR2>

This command sets the initial frequency.

Query Syntax	[SOURce :] : STEP : FREQuency?
Parameter	15.0 to 2000.0
Return parameters	<NR2>

STEP : SPHase <NR2>

This command sets the start phase of step mode.

Query Syntax	[SOURce :] : STEP : SPHase?
Parameter	0.00 to 359.99
Return parameters	<NR2>

STEP : SHAPe A | B

This command sets waveforms.

Query Syntax	[SOURce :] : STEP : SHAPe?
Parameter	A B
Return parameters	A B

STEP : DVOLtage <NR2>

This command sets the delta voltage in each step.

Query Syntax	[SOURce :] : STEP : DVOLtage?
Parameter	-300.0 to +300.0
Return parameters	<NR2>

STEP : DFRequency <NR2>

This command sets the delta frequency in each step.

Query Syntax	[SOURce :] : STEP : DFRequency?
Parameter	-2000.0 to +2000.0
Return parameters	<NR2>

STEP : DWELl <NR2>

This command sets the dwell time in each step.

Query Syntax	[SOURce :] : STEP : DWELl?
Parameter	0.000 to 999.999 sec
Return parameters	<NR2>

STEP : COUNT <NR1>

This command sets the number of times for the executing the step.

Query Syntax	[SOURCE :] : STEP : COUNT?
Parameter	0 to 30000
Return parameters	<NR1>

[SOURCE :]

: PULSe
: SYNC IMMEDIATE | PHASE
: SPHase <n>
: VOLTage <n>
: FREQuency <n>
: SHAPE <n>
: COUNT <n>
: DCYCLE <n>
: PERiod <n>
: QUIT

PULSe : SYNC IMMEDIATE | PHASE

If PULSe : SYNC PHASE is programmed, the AC source will synchronize the specified phase angle to output voltage in PULSE mode. The phase angle will be neglected if PULSe: SYNC IMM is programmed.

Query Syntax	[SOURCE :] : PULSe : SYNC?
Parameter	PHASE IMMEDIATE
Return parameters	PHAS IMM

PULSe : SPHase <NR2>

If PULSe : SPHase 90 is programmed, the AC source will not output the specified voltage until 90 degree is met. This command is invalid when PULSe: SYNC IMM is programmed.

Query Syntax	[SOURCE :] : PULSe : SPHase?
Parameter	0.00 to 359.99
Return parameters	<NR2>

PULSe : VOLTage <NR2>

This command sets voltage in the duty cycle of PULSE mode.

Query Syntax	[SOURce :] : PULSe : VOLTage?
Parameter	0.0 to 300.0
Return parameters	<NR2>

PULSe : FREQuency <NR2>

This command sets frequency in the duty cycle of PULSE mode.

Query Syntax	[SOURce :] : PULSe : FREQuency?
Parameter	0.00 to 2000.00
Return parameters	<NR2>

PULSe : SHAPe A | B

This command sets waveform A or B in the duty cycle of PULSE mode.

Query Syntax	[SOURce :] : PULSe : SHAPe?
Parameter	A B

PULSe: COUNT <NR1>

This command sets the number of pulses that are output in PULSE mode.

Query Syntax	[SOURce :] : PULSe : COUNT?
Parameter	1 to 60000 or INFINITY
Return parameters	<NR1>

PULSe : DCYClE <NR2>

This command sets the duty cycle of the triggered output pulse in PULSE mode.

Query Syntax	[SOURce :] : PULSe : DCYClE?
Parameter	0.01% to 100.00%
Return parameters	<NR2>

PULSe : PERiod <NR2>

This command sets the period of a triggered output pulse in PULSE mode.

Query Syntax	[SOURce :] : PULSe : PERiod?
Parameter	0.0 to 999999.0 ms
Return parameters	<NR2>

PULSe : QUIT

This command stops the generation of output pulses.

SYSTem

: VERSion?
: LOCAl
: REMote
: RWLock

SYSTem : VERSion?

This query requests the AC source to identify itself.

Return parameters Chroma ATE, 6530, 1234, 2.01

SYSTem : LOCAl

This command can only be used under the control of RS-232C. If SYST : LOC is programmed, the AC source will be set in LOCAL state, and the front panel will work.

SYSTem : REMote

This command can only be used under the control of RS-232C. If SYST : REM is programmed, the AC source will be set in REMOTE state, and the front panel will be disabled except the Local key.

SYSTem : RWLock

This command can only be used under the control of RS-232C. If SYST : RWL is programmed, the AC source will be set in Remote-Lockout state, and the front panel will be disabled.

6.7 Command Summary

Common Commands:

* CLS	Clear status
* ESE<n>	Standard event status enable
* ESE?	Return standard event status enable
* IDN?	Return the AC source identification
* RLC<n>	Recall the AC source file

* SAV<n> Save the AC source status

Instrument Commands:

FETCh | MEASure
[: SCALar]
 : CURRent
 : AC?
 : AMPLitude : MAXimum?
 : CRESfactor?

FETCh | MEASure
[: SCALar]
 : FREQuency?

FETCh | MEASure
[: SCALar]
 : POWer
 : AC
 [: REAL] ?
 : APParent?
 : REACTive?
 : PFACTor?
 : TOTAl?

FETCh | MEASure
[: SCALar]
 : VOLTage
 : AC?

INITiate
[: IMMEDIATE]
: CONTinuous
 : SEQuence1 ON | OFF

INSTrument
 : COUple ALL | NONE
 : NSElect <n>
 : SElect <OUTPut>

ORELay ON | OFF

OUTPut
[: STATe] <bool>

: PROTection
: CLear
: DELay <n>

RANGe HIGH | LOW

[SOURce :]
CURRent
[: LEVel]
[: IMMEDIATE]
[: AMPLitude] <n>

[SOURce :]
FREQuency
[: CW | : IMMEDIATE] <n>

[SOURce :]
FUNction
: SHAPe A/B
[: A/B] [shape]
: TRANsient ON/OFF

[SOURce :]
VOLTage
[: LEVel]
[: IMMEDIATE]
[: AMPLitude] <n>

SYSTEM
: ERRor?

TRACe | DATA
[: DATA] <US1, . . . ,US6>, <D1, D2. . . >

TRIGger
[: SEQuence1 | : TRANsient]
[: IMMEDIATE]

TPHase <NR2>
: SYNC IMMEDIATE | PHASe

[SOURCE :]

LIST

```

: COUNTt <n> | INFIinity
: SYNC IMMEDIATE | PHASe
: SPHase
: QUIT
: BASE TIME | CYCLe
: DWEL <n>{, <n>}
      : POINTs?
: FREQuency [: LEVel] <n>{, <n>}
      : POINTs?

: SHAPe A | B{, A | B}
      POINTs?
: START <n>{, <n>}
: END <n>{, <n>}
: LOOP <n>{, <n>}
: STEPno <n>{, <n>}

```

[SOURCE :]

: STEP

```

: SYNC IMMEDIATE | PHASe
: SPHase<n>
: VOLTage <n>
: FREQuency <n>
: SHAPe <n>
: DVOLTage <n>
: DFRrequency <n>
: DWELI <n>
: COUNT <n>
: QUIT

```

[SOURCE :]

: PULSe

```

: SYNC IMMEDIATE | PHASe
: SPHase <n>
: VOLTage <n>
: FREQuency <n>
: SHAPe <n>
: COUNT <n> | INFIinity
: DCYCLe <n>
: PERiod <n>
: QUIT

```

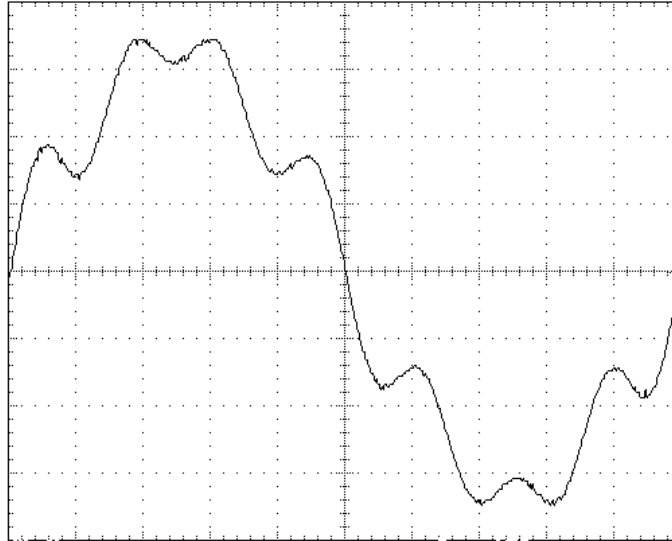
SYSTem

- : VERSion?
- : LOCAl
- : REMote
- : RWLock

Appendix A Built-in Waveforms

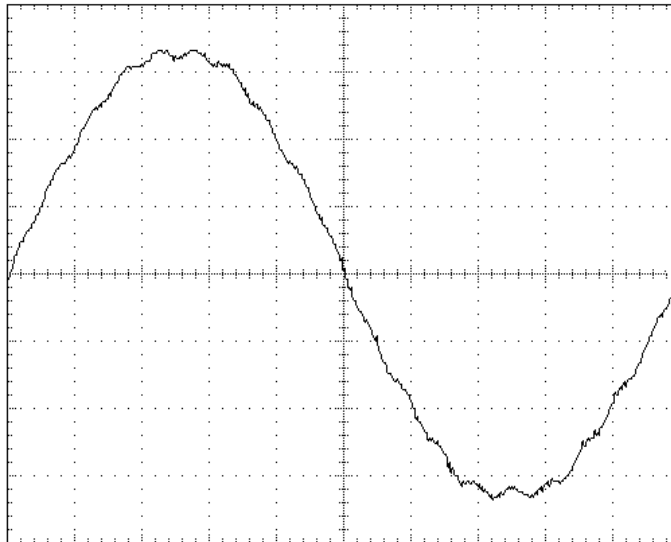
DST01

Harmonic	%
2	2.07
5	9.80
7	15.80
8	2.16



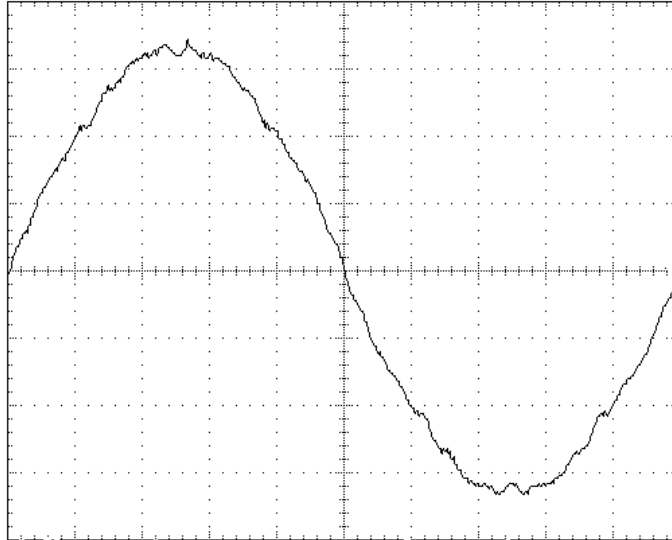
DST02

Harmonic	%
3	1.5
7	1.5
19	2.0



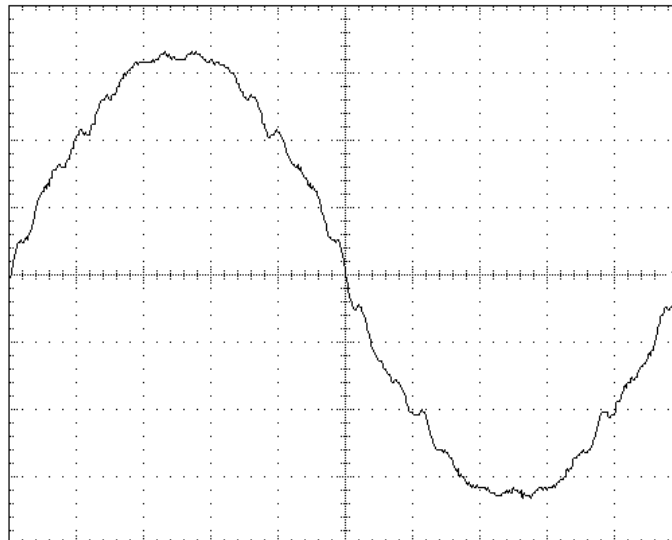
DST03

Harmonic	%
3	2.0
5	1.4
7	2.0
23	1.4
31	1.0



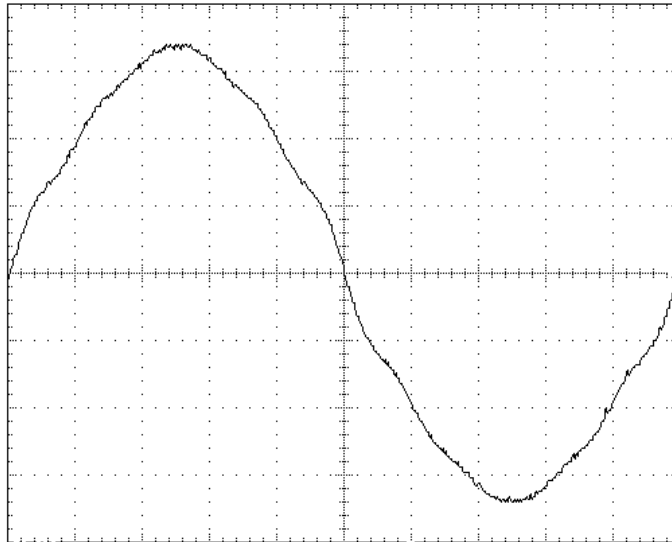
DST04

Harmonic	%
3	2.5
5	1.9
7	2.5
23	1.9
25	1.1
31	1.5
33	1.1



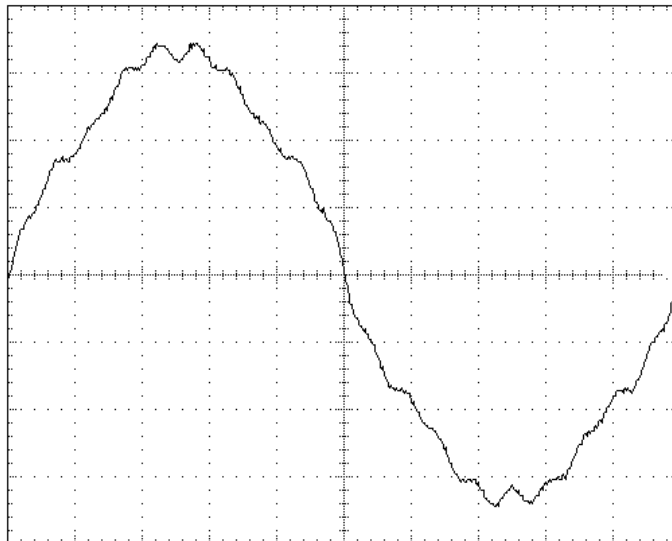
DST05

Harmonic	%
3	1.1
5	2.8
7	1.4
9	2.3
11	1.5



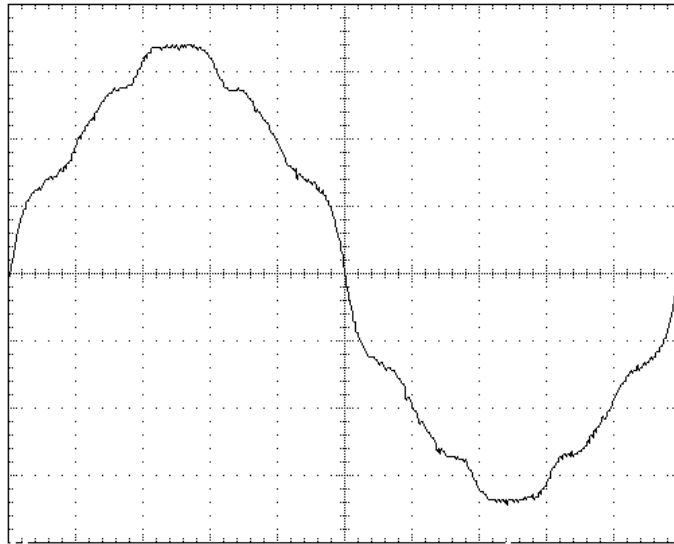
DST06

Harmonic	%
3	1.65
5	4.20
7	3.45
15	1.05
19	3.00



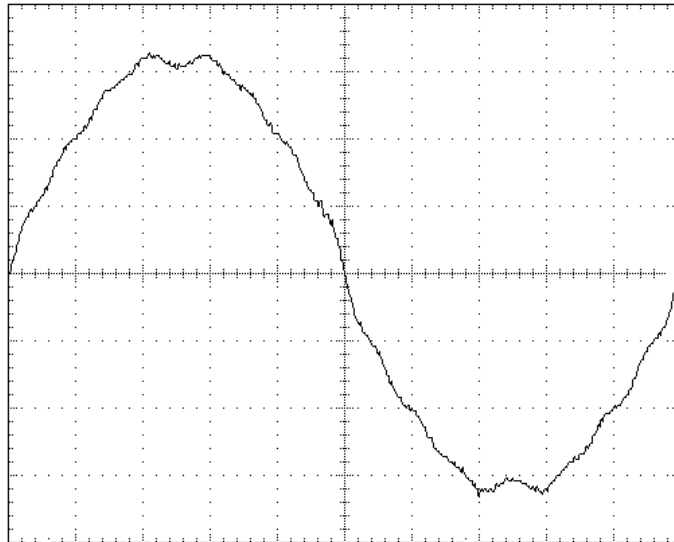
DST07

Harmonic	%
3	2.2
5	5.6
7	2.8
9	4.6
11	3.0
15	1.4
21	1.0



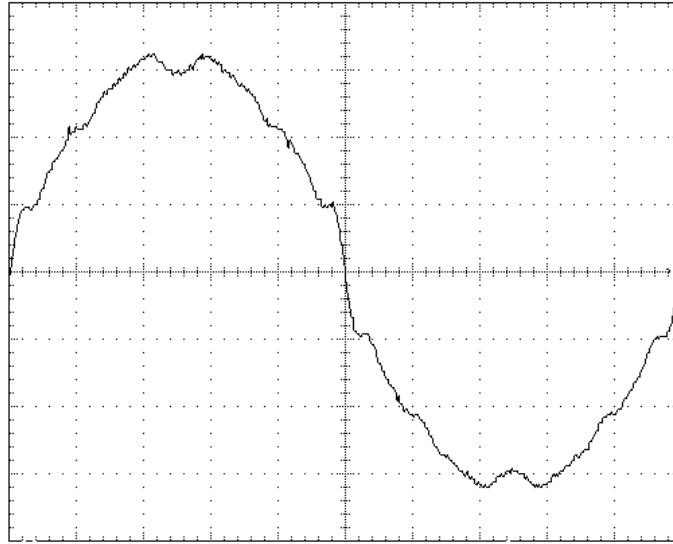
DST08

Harmonic	%
3	4.9
5	1.6
7	2.7
11	1.4
15	2.0
17	1.1



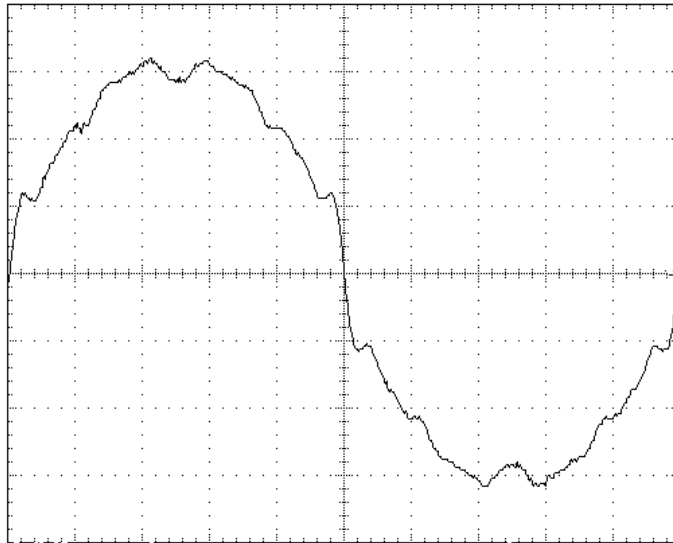
DST09

Harmonic	%
3	7.35
5	2.40
7	4.05
11	2.10
13	1.05
15	3.00
17	1.65
19	1.05
21	1.05
23	1.20
25	1.05



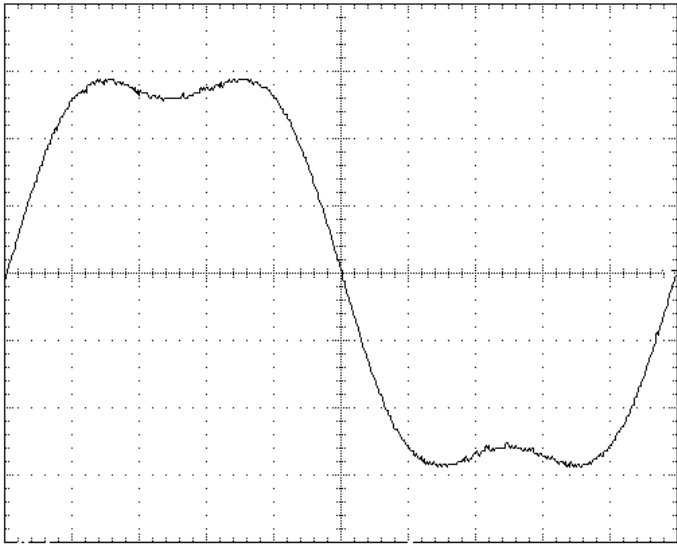
DST010

Harmonic	%
3	9.8
5	3.2
7	5.4
9	1.2
11	2.8
13	1.4
15	4.0
17	2.2
19	1.4
21	1.4
23	1.6
25	1.4



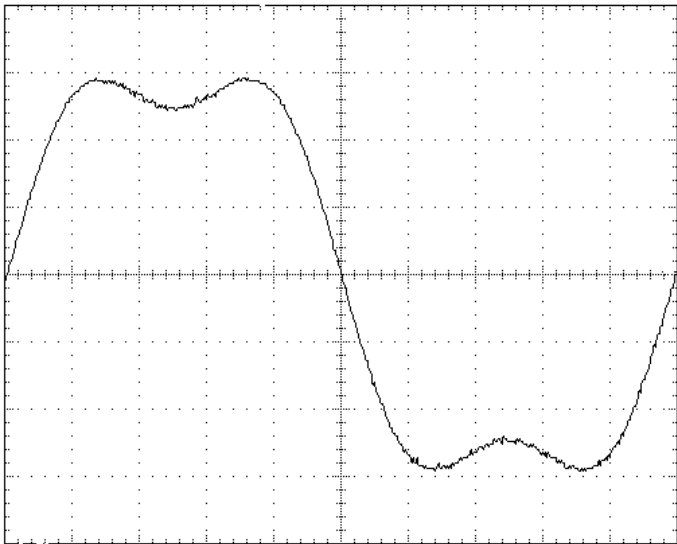
DST011

Harmonic	%
3	17.75



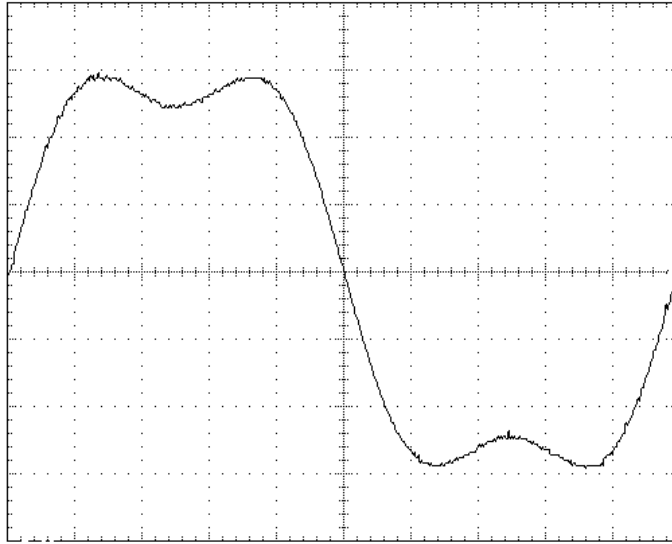
DST012

Harmonic	%
3	21.25



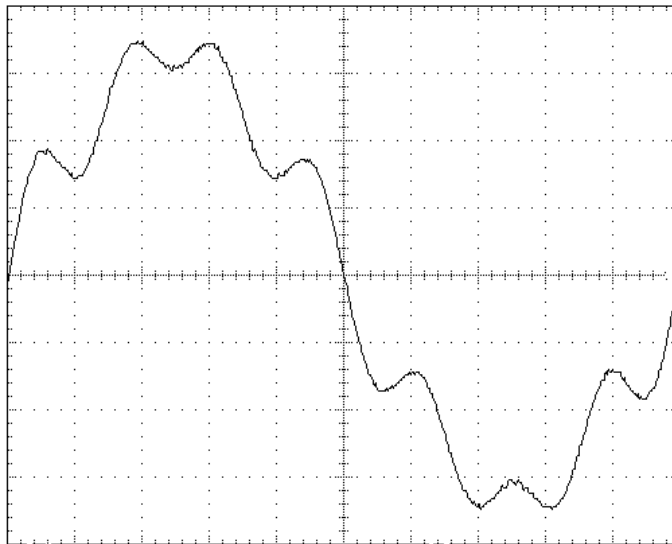
DST013

Harmonic	%
3	24.5



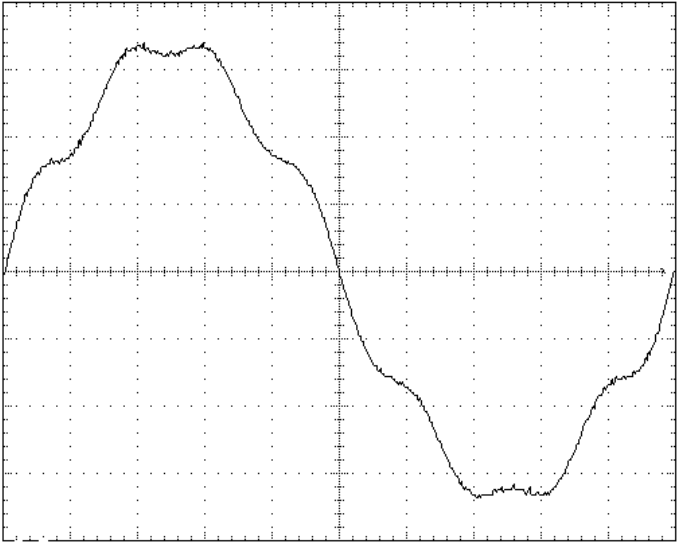
DST014

Harmonic	%
2	2.3
5	9.8
7	15.8
8	2.5



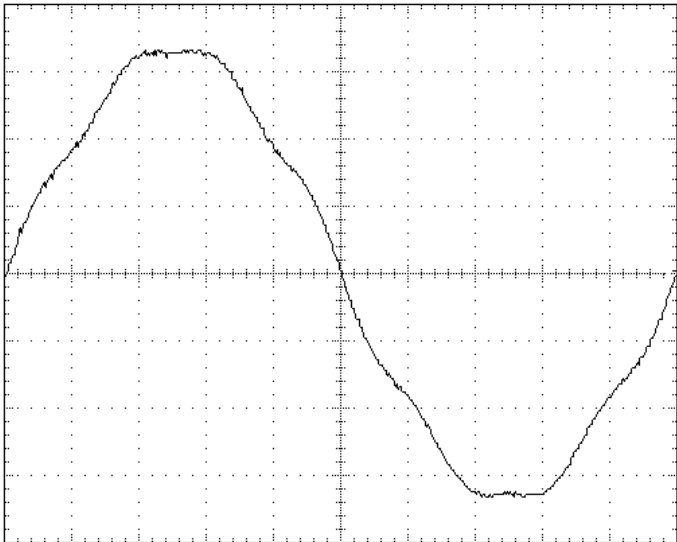
DST015

Harmonic	%
2	1.15
5	4.90
7	7.90
8	1.25



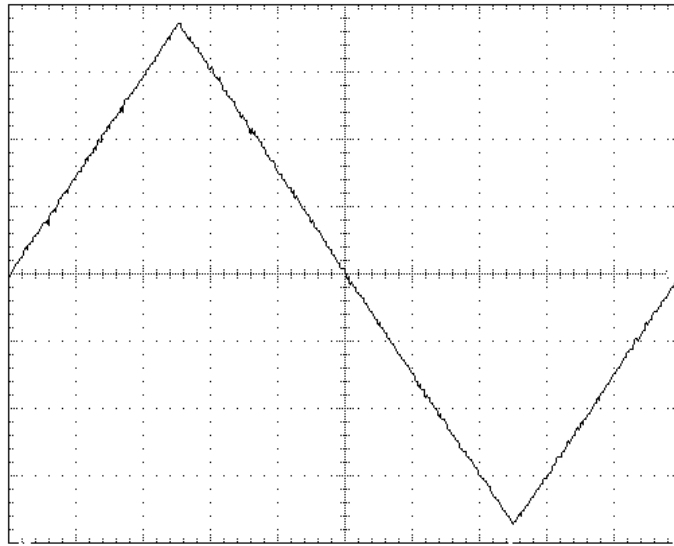
DST016

Harmonic	%
5	2.45
7	3.95



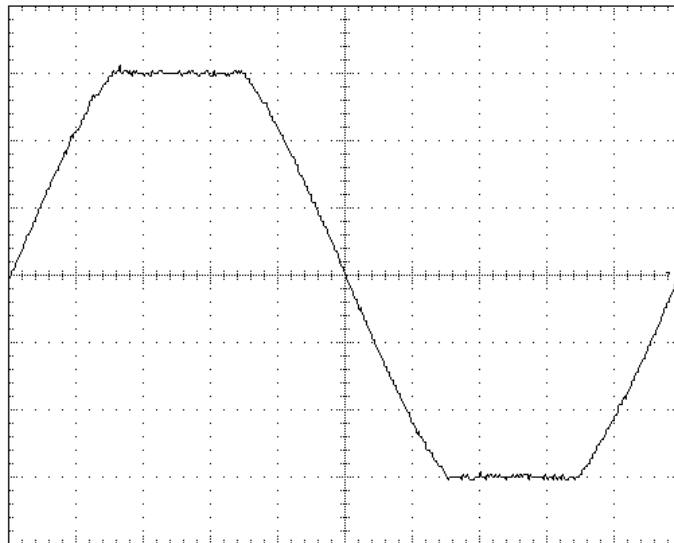
DST017

Harmonic	%
3	11.00
5	4.05
7	2.00
9	1.30



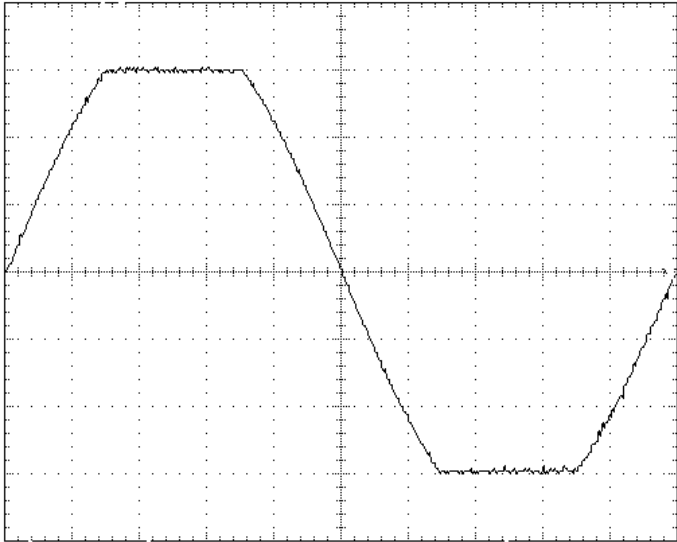
DST018

Harmonic	%
3	7.17
5	3.42
9	0.80



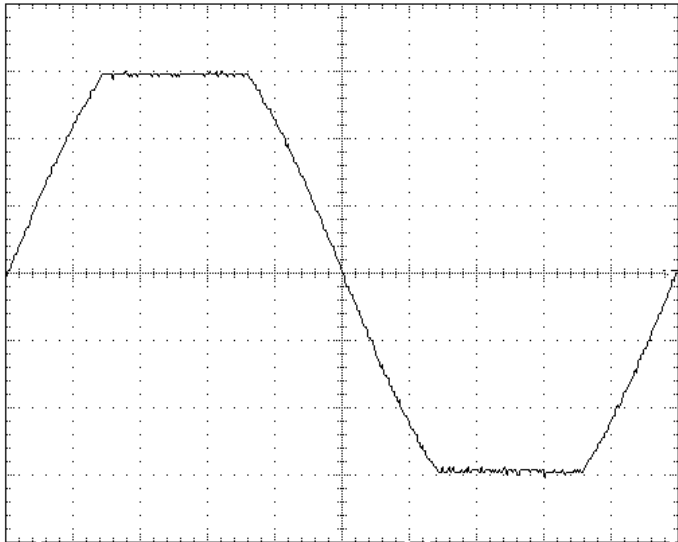
DST019

Harmonic	%
3	8.11
5	3.48
9	1.00



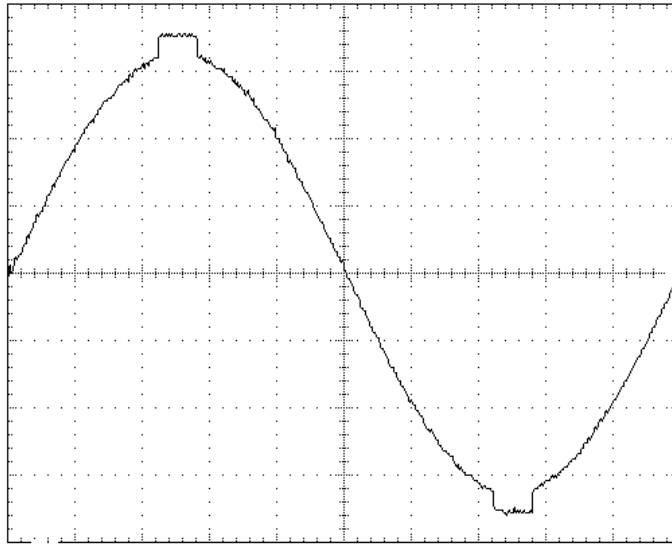
DST020

Harmonic	%
3	9.38
5	3.44
9	1.15



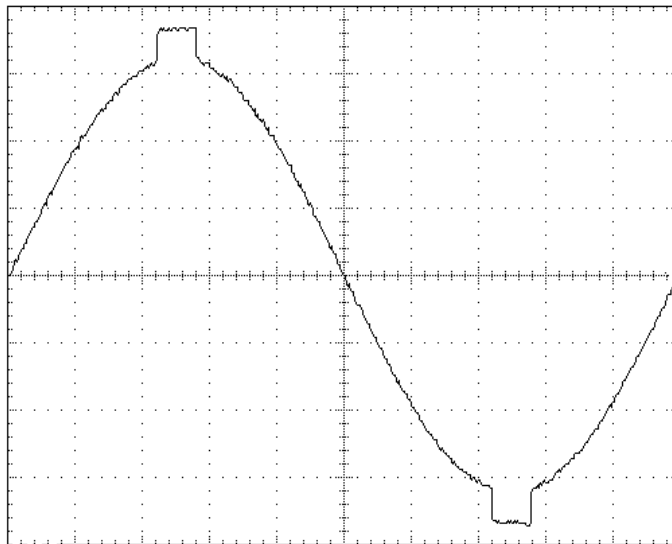
DST021

Harmonic	%
3	2.00
5	1.80
7	1.60
9	1.23
11	0.90



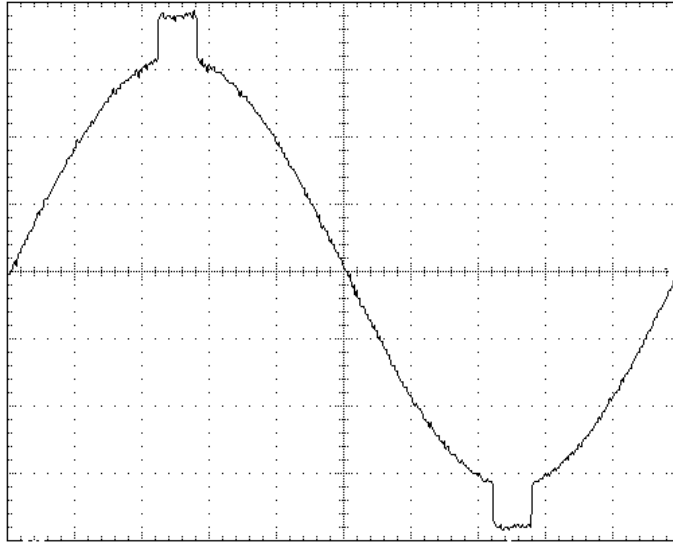
DST022

Harmonic	%
3	3.00
5	2.75
7	2.40
9	2.00
11	1.40
13	0.80



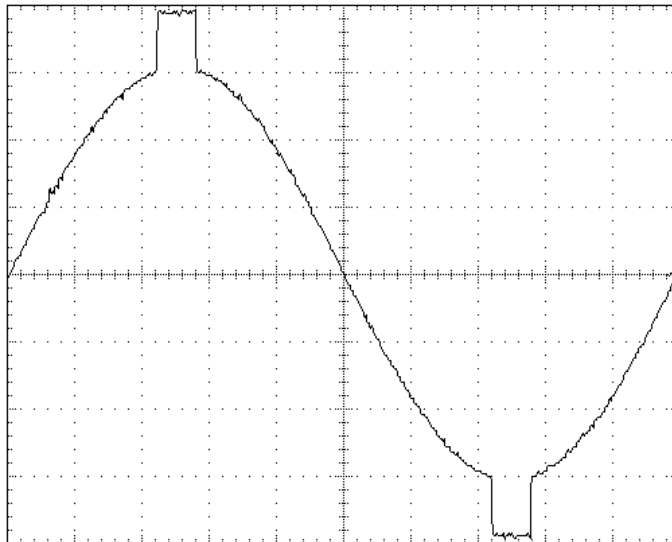
DST023

Harmonic	%
3	4.15
5	3.80
7	3.24
9	2.60
11	2.00
13	1.25



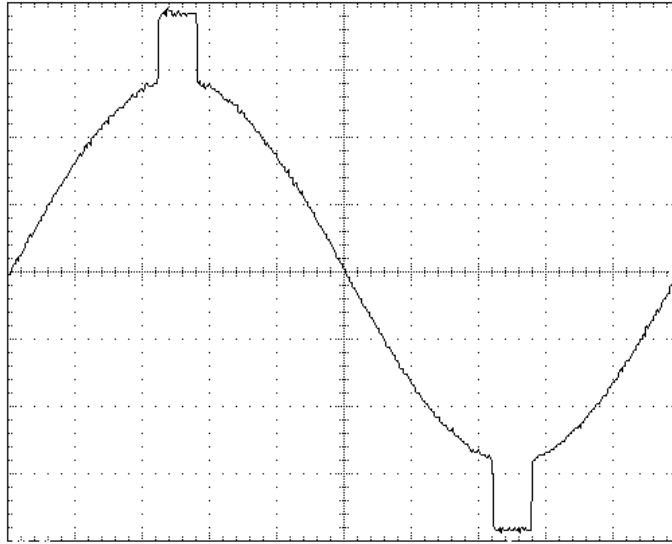
DST024

Harmonic	%
3	5.63
5	5.13
7	4.42
9	3.56
11	2.63
13	1.68
15	0.79
21	1.04
23	1.27
25	1.32
27	1.20
29	0.95



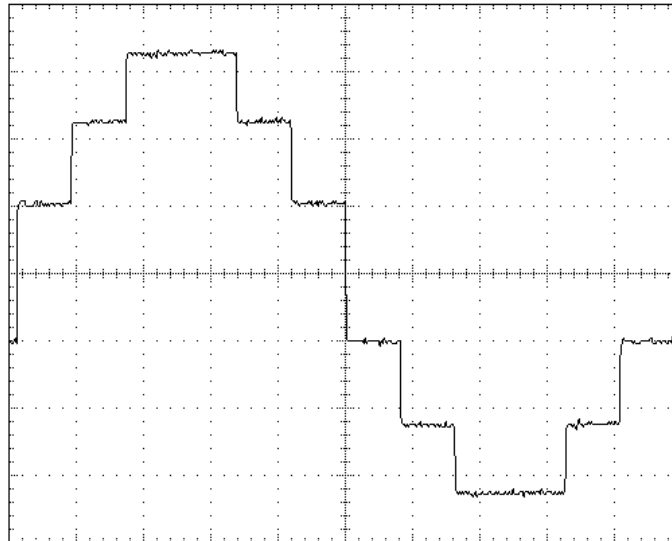
DST025

Harmonic	%
3	7.28
5	6.63
7	5.71
9	4.61
11	3.42
13	2.19
15	1.04
21	1.32
23	1.63
25	1.69
27	1.54
29	1.22



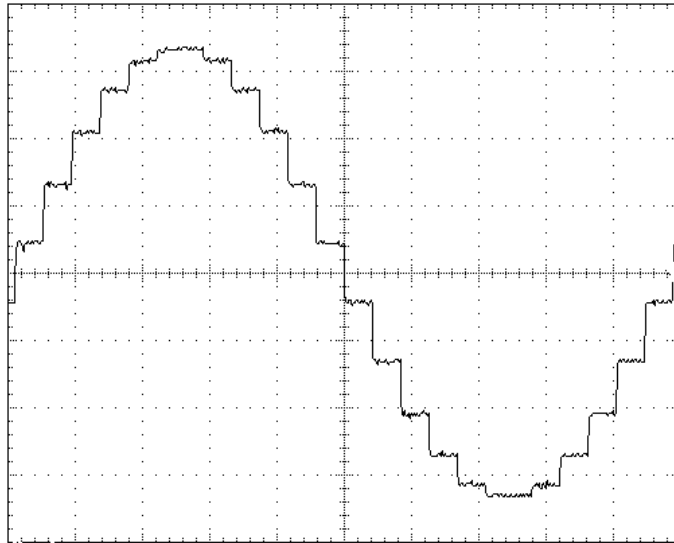
DST026

Harmonic	%
5	3.54
7	2.68
11	8.87
13	7.86
19	1.04
23	4.11
25	4.13
35	2.61
37	2.82



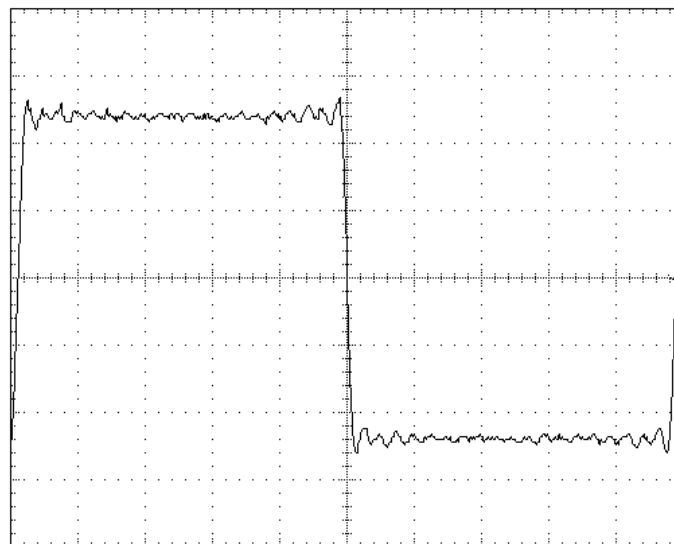
DST027

Harmonic	%
21	1.38
23	5.39
25	2.29



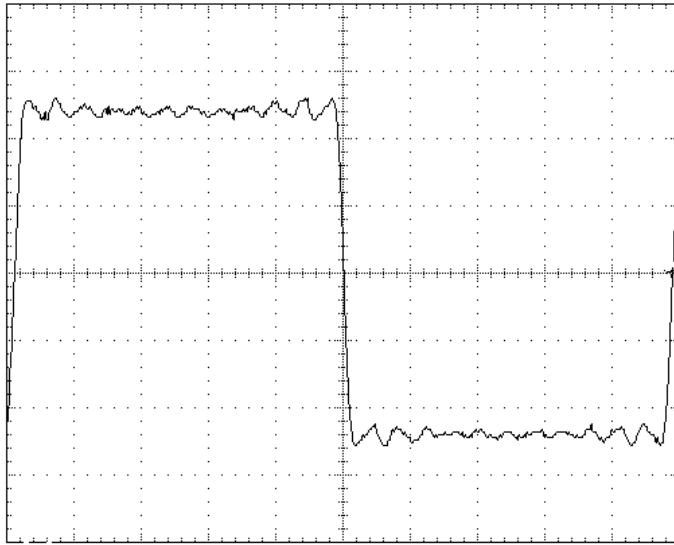
DST028

Harmonic	%
3	33.3333
5	20
7	13.8
9	10.8
11	8.5
13	7.2
15	6.0
17	5.0
19	5.0
21	4.5
23	4.0
25	3.5
27	2.95
29	2.5
31	2.0
33	2.0
35	2.0
37	2.0
39	2.0



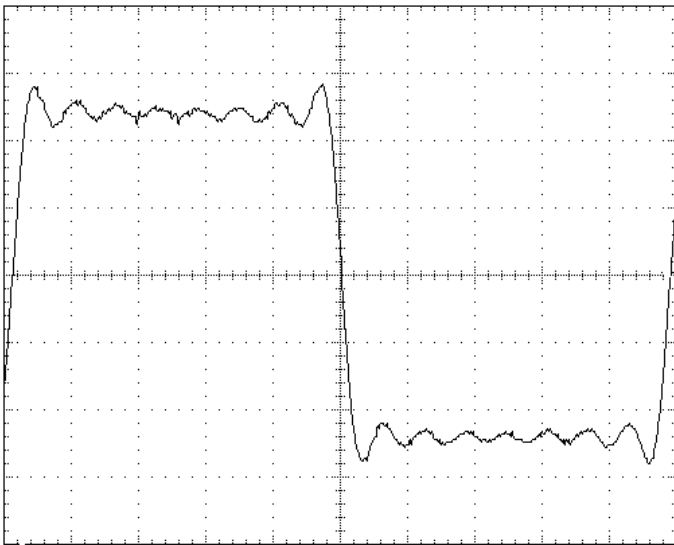
DST029

Harmonic	%
3	33.3333
5	20.0
7	13.8
9	10.8
11	8.5
13	7.2
15	6.0
17	5.0
19	5.0
21	4.5
23	4.0
25	1.0
27	1.0
29	1.0
31	1.0
33	1.0
35	1.0
37	1.0
39	1.0



DST030

Harmonic	%
3	33.3333
5	20.0
7	13.8
9	10.8
11	8.5
13	7.2
15	5.5



Appendix B Parameters in Mode Operations

Programmable Parameters for Mode = STEP

Parameters	Options	Description
V	0 – 300 (@ 0.1) V	It is the initial voltage.
F	15 – 2K (@ 0.01) Hz	It is the initial frequency.
Waveform	A/B	You can choose waveform A or B, which is defined in “CONFIG”.
Sync. source Phase	Immed/phase 0 – 359.99 (@ 0.01) Degree	These two parameters are for you to set the output waveform, and synchronize it with source waveform immediately, or with a phase difference. It is same as the <i>Output Setting</i> described in 3.1.3.
dV	–300 – +300V (@ 0.1 V)	It is a constant increment from dV to V if dV > 0, or decrement if dV < 0.
dF	–2000 – +2000 Hz (@ 0.1 Hz)	It is similar to dV for programming frequency increment (decrement).
dTrigger	Auto / Manual	Select “Auto”, the output V and F will keep changing in every period (=Dwell time). See next parameter.
Dwell time	0 – 999999 (@ 0.1) mSec.	It is the duration before each output state changes to V or F.
count	0 – 65535 1 – 30000	They are the total steps for output state change. If you select 0, the AC source will output according to the initial parameter without executing “STEP” function.

Programmable Parameters for Mode = LIST

Parameters	Options	Description
Base	Cyc/Tim	There are two kinds of bases for the setting of LIST mode. One is Cycle and another is Time. If you select Cycle, it means the output of LIST mode will use inverse frequency as base. If you select Time, it means the output of LIST mode will use time as base.
count	0 – 65535	They are the total loops for repetition of entire listed output states. If you select 0, the AC source will repeat output infinitely.
Trigger	AUTO/MANUAL	Selecting “AUTO” indicates the value V or F changes automatically in every period t (for the setting of t see the description below.) Selecting “MANUAL” means it changes manually with soft key.
Sync. source Phase	Immed/phase 0 – 359.99	These two parameters are for you to set output waveform, and synchronize it with source waveform immediately, or with a phase difference. It is same as <i>Output Setting</i> described in 3.1.3.
Dwell point		
Start	0 – 39	It is the loop start sequence number.
End	0 – 39	It is the loop end sequence number.
Loop	1 – 9999	It is the loop count number.
Vstart	0 – 300 (@ 0.1) V	The specified output V is defined at each sequence for the first step.
Vend	0 – 300 (@ 0.1) V	The specified output V is defined at each sequence for the last step.
F	15 – 2K (@ 0.1) Hz	The specified output F is defined at each sequence.
Cycle	0.0 – 60000.0	It is the sequence duration. The execution stops when Cycle=0.
Time	0 – 999999 mS (@ 1 mSec)	It is the sequence duration. The execution stops when Time=0.
StepNO	1– 999	It is the step number for all sequences.
Waveform	A/B	You can choose waveform A or B defined in “CONFIG”.

Programmable Parameters for Mode = PULSE

Parameters	Options	Description
V	0 – 300 (@ 0.1) V	It is the output Voltage in volt.
F	15 – 2K (@ 0.01) Hz	It is the output Frequency in Hertz.
Waveform	A/B	You can choose waveform A or B, which is defined in “CONFIG”.
Sync. source Phase	Immed/phase 0 – 359.99 (@ 0.01) Degree	These two parameters are for you to set output waveform, and synchronize it with source waveform immediately, or with a phase difference. It is same as <i>Output Setting</i> described in 3.1.3.
Duty	0 – 100 (@ 0.01) %	The percentage indicates the time interval for output over a period.
Count	0 – 65535 loops	They are the total number of times for repetition of entire listed output states. If you select 0, the AC source will repeat output infinitely.
Period	0.1 – 999999 (@ 0.1) mS	It is the duration before the output state changes to V or F at each step.
Trigger	AUTO/MANUAL	Selecting “AUTO” indicates the output V and F keep change stepwise in every period t (see the description below). Selecting “MANUAL” changes the output state, and wait for triggering manual.

Note: For the 3Ø output in 6590, whether in step, list or pulse mode, another parameter “controlled phase = Ø1/Ø1+Ø2+Ø3” is available for selection. Selection of Ø1 makes only Ø1 output change as the mode is programmed, while Ø1+Ø2+Ø3 makes all outputs do in the same way.

Appendix C Pin Assignment of User Interface

25-Pin D-Type Male Connector:

Pin No.	Signal	Pin No.	Signal	Description
1	GND	14	System Used	
2	GND	15	System Used	
3	GND	16	System Used	
4	GND	17	System Used	
5	GND	18	System Used	
6	GND	19	System Used	
7	GND	20	System Used	
8	GND	21	System Used	
9	GND	22		
10	GND	23		
11	GND	24		
12	System Used	25		
13	System Used			

Appendix D Pin Assignment of Printer Interface

25-Pin D-Type Female Connector:

Pin No.	Signal	Direction	Pin No.	Signal	Direction
1	$\overline{\text{STROBE}}$	Out	14	$\overline{\text{FF}}$	Out
2	DATA0	Out	15	$\overline{\text{ERROR}}$	In
3	DATA1	Out	16	$\overline{\text{INIT}}$	Out
4	DATA2	Out	17	$\overline{\text{SLCT IN}}$	Out
5	DATA3	Out	18	GND	
6	DATA4	Out	19	GND	
7	DATA5	Out	20	GND	
8	DATA6	Out	21	GND	
9	DATA7	Out	22	GND	
10	$\overline{\text{ACK}}$	In	23	GND	
11	BUSY	In	24	GND	
12	PE	In	25	GND	
13	----				

Appendix E Pin Assignment of TTL I/O

9-Pin D-Type Female Connector:

Pin No.	Signal	Direction	Pin No.	Signal	Direction
1	$\overline{\text{TRANS}}$	Transient	6	GND	
2	AC ON	Output enable	7	GND	
3	$\overline{\text{TRIG}}$	Trigger	8	GND	
4	$\overline{\text{INH}}$	Remote inhibit	9	GND	
5	-----				

Appendix F Table of Output Voltage RMS Range of Non-Sinusoidal Waveforms

Waveform	Ratio	V range	V range
SIN	1	(150V)	(300V)
SQR	1	150	300
CSIN	1	150	300
DST01	1.0326	145.3	290.5
DST02	1	150	300
DST03	1	150	300
DST04	1	150	300
DST05	1.0101	148.5	297
DST06	1.0225	146.7	293.4
DST07	1.0141	147.9	295.8
DST08	1	150	300
DST09	1	150	300
DST10	1	150	300
DST11	1	150	300
DST12	1	150	300
DST13	1	150	300
DST14	1.0326	145.3	290.5
DST15	1	150	300
DST16	1.2211	122.8	245.7
DST17	1	150	300
DST18	1	150	300
DST19	1	150	300
DST20	1	150	300
DST21	1.0635	141	282.1
DST22	1.0985	136.5	273.1
DST23	1.1354	132.1	264.2
DST24	1.1844	126.6	253.3
DST25	1.2366	121.3	242.6
DST26	1	150	300
DST27	1	150	300
DST28	1	150	300
DST29	1	150	300
DST30	1	150	300